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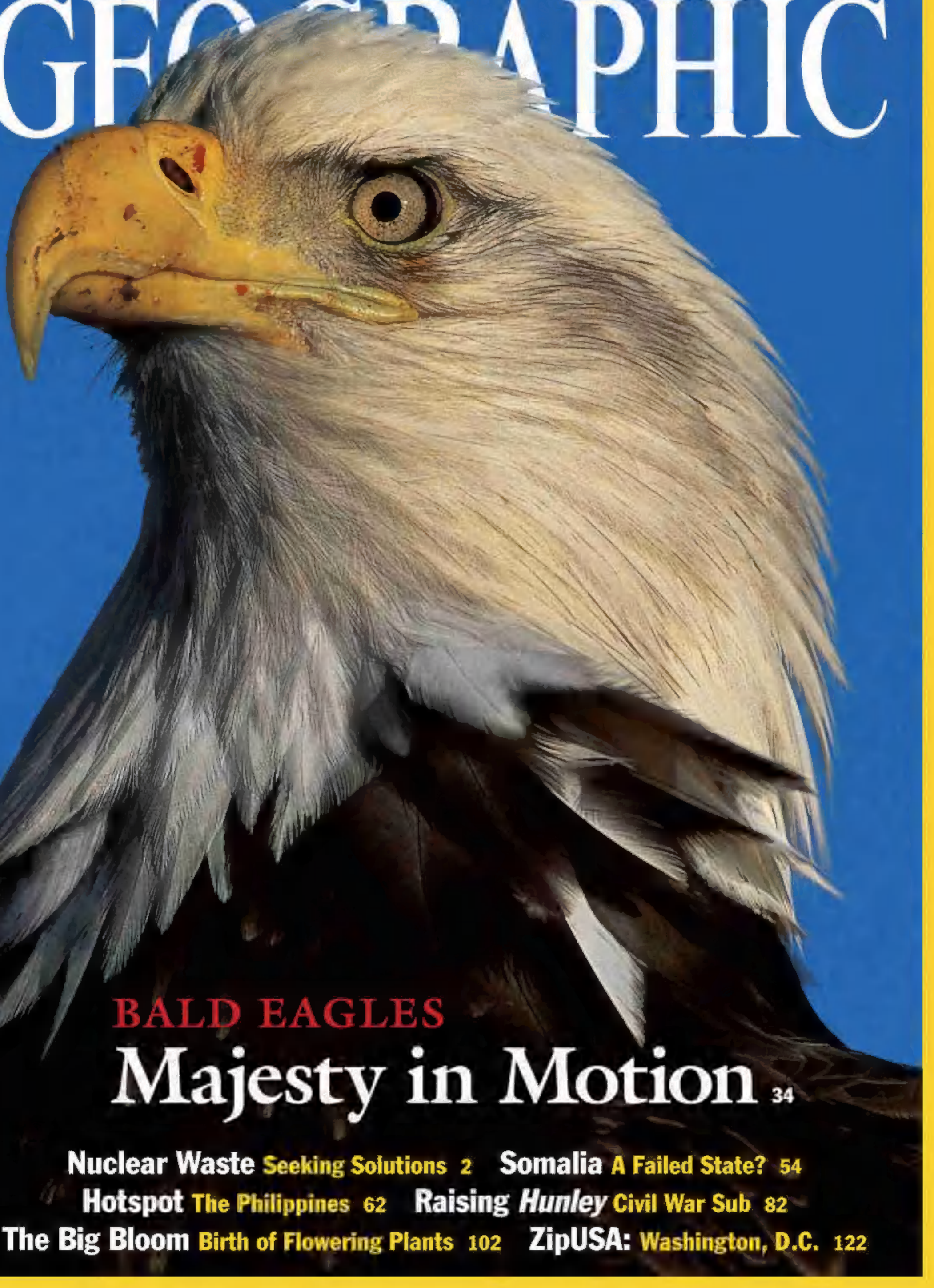

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Majesty in Motion 34

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VOL. 202 • NO. 1 • JULY 2002

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THE COVER

They're back! A mature bald eagle perches near Homer, Alaska. Plentiful in the north, a booming population now wings across the lower 48.
BY NORBERT ROSING

ON THE NGM WEBSITE

nationalgeographic.com/ngm/0207
SIGHTS & SOUNDS Eagles reveal their majesty in motion.
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From the Editor

Two things happened at 5:29 a.m. on July 16, 1945—moments before this photograph was made. Trinity, the world's first atomic bomb test, was exploded near Alamogordo, New Mexico. And the problem of what to do with nuclear waste was born.

The problem is still with us 57 years later. It's the kind of problem that will stick around for a million years, transcending even the issues of transport, cleanup, and storage that writer Mike Long addresses in this issue. In February President Bush recommended that Nevada's Yucca Mountain be developed as the country's first long-term repository for nuclear waste. Advocates say the facility, deep underground, will safely contain radioactive waste for at least 10,000 years. Foes of the plan say that's not nearly long enough.

Who knows how safe these plans can be? Though above-ground nuclear events such as Trinity are long over in this country, the Centers for Disease Control and Prevention and the National Cancer Institute recently reported that, because of such testing, every person living in the contiguous United States since 1951 has been exposed to radioactive fallout, perhaps contributing to the increase of certain cancers. It looks as if we'll be dealing with the fallout from nuclear waste —radioactive and otherwise—for a long time to come.

Bill Allen

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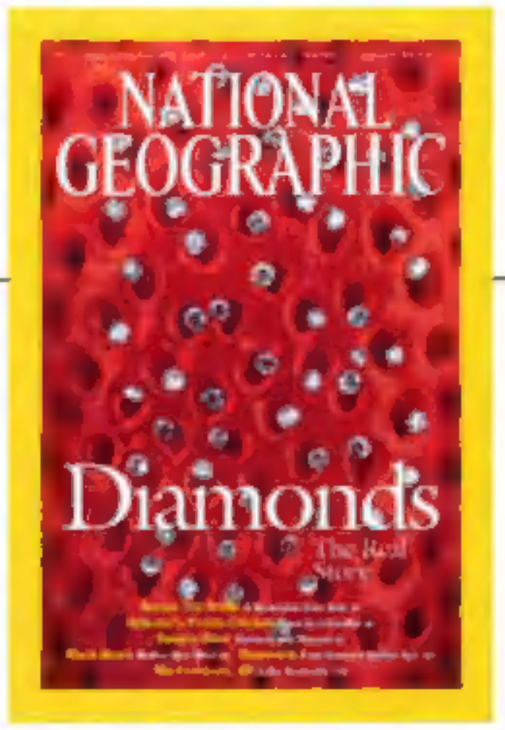
Forum



March 2002

For some of our readers, diamonds are no longer a girl's best friend. "I will never purchase, accept, or wear diamonds again," wrote one woman, after reading about the atrocities caused by conflict diamonds. The executive director of the Jewelers Vigilance Committee wrote that the diamond industry has been working with the UN to create a system to protect the supply chain from abuse.

Diamonds

After 19 years of marriage I was going to ask my husband to (finally) present me with a diamond engagement ring. After reading this article, however, I have decided that I cannot support an industry that has caused, even indirectly, such horror and suffering.

JANET LOVINS
Chipley, Florida

Women of developed nations, unite! At 50 percent of the population, we have enormous buying power, and this power can be used to change the diamond industry. Tell that special person not to purchase a diamond unless it is certified as mined in an environmentally friendly, humane way. If we create a demand for this product, the industry will have to meet that demand. Of course, as part of a brilliant marketing scheme, the need for such certification could be used as an excuse to raise the price of diamonds. Not that a small piece of compressed carbon isn't expensive enough.

SHEILA SOPROVICH
Ottawa, Ontario

RAND Diamond is a third-generation company that has been a De Beers sightholder since 1947. We deplore human suffering caused by rebels and are combating it. RAND has taken the unprecedented step of identifying each diamond and tracking it from the time we receive it from De Beers through to our own cutting factory and the retail counter.

SEAN COHEN
President, RAND Diamond
New York, New York

I was appalled when I read that workers in a Namibian mine have to endure daily x-ray examinations. In Germany x-ray doses that patients receive are monitored closely. I would like to know how many of those workers develop cancer or how many handicapped children are born as a result of De Beers's security measures.

GABOR MESTER
Kempten, Germany

According to De Beers, while all workers pass through low-dose scanning machines every day at

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The Nissan Pathfinder has crossed the wild and rugged expanses of untamed Africa–and now it's your turn. Enter online to win a 13-day photographic African safari for two, filled with stunning landscapes, up-close wildlife and unbelievable experiences. You'll join a National Geographic Expeditions trip led by a world-renowned National Geographic photographer. From the wild savanna to private game reserves, it's a unique experience that you'll never forget, starting at nationalgeographic.com/pathtoadventure. To learn more about the Nissan Pathfinder, just go to NissanDriven.com.


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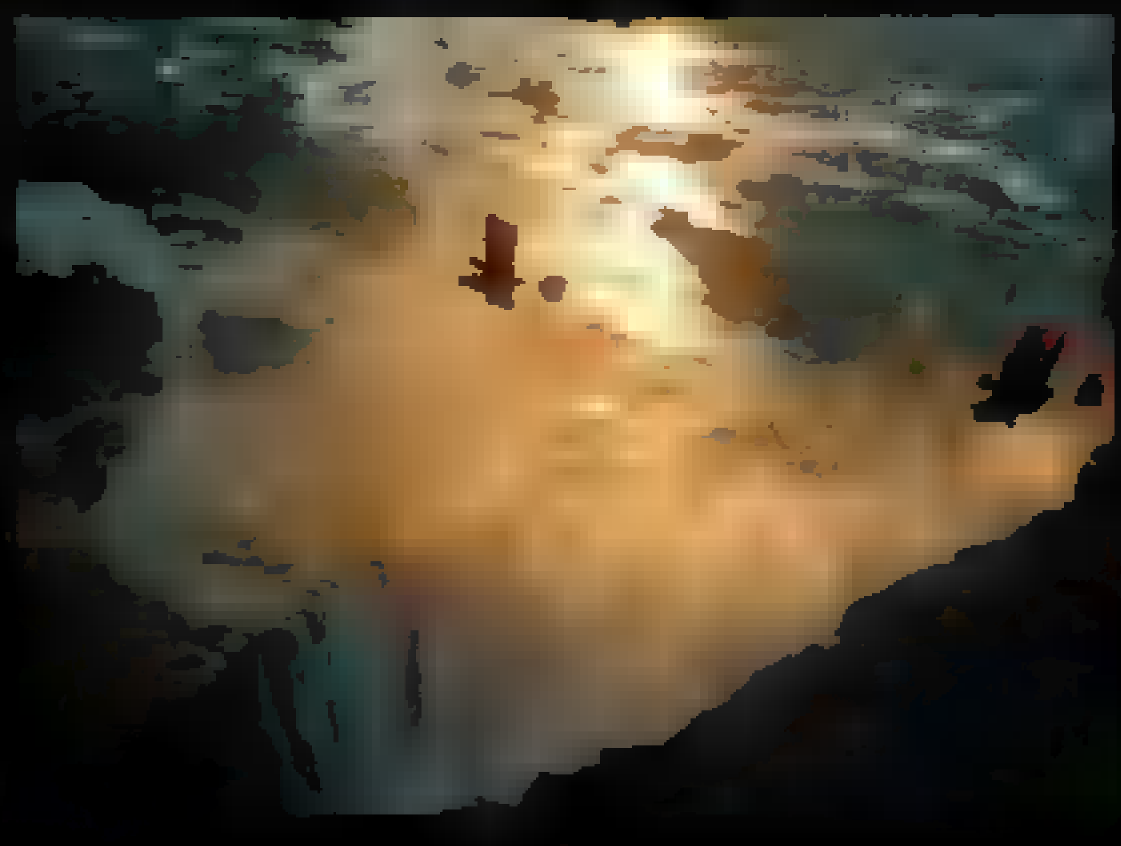

THE 240-HP NISSAN PATHFINDER. Although it's [illegible] ever [illegible] drive [illegible], isn't it nice [illegible] it wouldn't be a [illegible] V6 [illegible] tames the [illegible] terrain. A [illegible] 4WD [illegible] reduces mountain ranges to [illegible]. Plus the leather-appointed interior makes sure [illegible] never break a sweat. Find out more. Call 800-326-9116 or [illegible] NissanDriven.com. [illegible] to [illegible] the "Path to Adventure" photo safari sweepstakes at [illegible]. Once, you'll [illegible] a vacation slide show worth [illegible].

NISSAN

DRIVEN.

Danube River

In the 1980s I spent some wonderful weeks studying birdlife and aquatic flora and fauna and canoeing and swimming in the delta known as Szigetkoz in northwest Hungary. It has now become a nightmare. The construction of the Slovakian Gabčíkovo Dam has left much of this stretch of the Danube dry. The Slovaks divert more than 80 percent of the river's water here to supply the dam, which produces 10 percent of their electricity. Even Slovakian hydrotechnical experts at international forums have admitted that the dam is a failure. It was another sad hatching of the communist leadership. The people did not hold a referendum, and this was the result. Mankind has in a few years messed up what it took nature centuries to develop.

TAMAS S. KISS
Budapest, Hungary

I was astonished to see no mention of Vukovar, the heroic Croatian city that was totally destroyed by Serbs and the Yugoslav People's Army in 1991. Thousands of Vukovar inhabitants were killed and displaced by Serbs. The majority of survivors are still refugees.

MAJA DUBRAVICA
Zagreb, Croatia

Danube author Cliff Tarpy writes of the tragedy of Vukovar in his Field Notes section on our website: nationalgeographic.com/ngm/0203.

KASHI

The Danube yields an additional dark event. In 1527 Protestant reformer Balthasar Hubmaier and his wife, Elizabeth Hugline, were imprisoned in Vienna because of their "heretical" teachings. After they refused to recant, Holy Roman Emperor Ferdinand I ordered Hubmaier to be burned at the stake and his wife to be drowned in the Danube.

TEMP SPARKMAN
Kansas City, Missouri

the mine, the machines are activated only randomly.

It was with great interest that I read the March edition. Not the least because of the extensive cooperation given by my colleagues over the past two years facilitating this article. Yet in From the Editor you ignore the remarkable contribution that the diamond industry has made to the development of stable democratic economies in southern Africa and elsewhere. You highlight the wholly unsubstantiated assertion that "the diamond trade out of Sierra Leone has pumped millions into Osama bin Laden's al Qaeda network in recent years." Government sources on both sides of the Atlantic have no intelligence to show there is any link between diamonds and terrorism. To suggest that there is, at a time of understandable public concern, is to alarm consumers unnecessarily and risk harming the legitimate diamond trade on which more than two million people worldwide depend.

R MORE O'FERRALL
Director of Public and Corporate Affairs, De Beers
London, England

While we erred in attributing our statement about al Qaeda and the diamond trade to the FBI—we should have cited "intelligence sources"—we stand by the accuracy of the statement.

Attwater's Prairie-chickens

Douglas Chadwick's prose made me realize the finality of extinction and made me reexamine my views about endangered species. I immediately looked at your Web page and discovered the small ways in which I could help Attwater's prairie-chickens.

KATIE STEVENS
Moab, Utah

My father's first cousin Frances Hamerstrom, a well-respected wildlife biologist, was one of the people responsible for keeping the greater prairie-chicken from extinction in Wisconsin. She recounts in her book *Strictly for the Chickens* that she was playing tennis as a child on Martha's Vineyard on May 12, 1916, when wildfire swept through 20 square miles of heath hen habitat, killing most of the population. By 1932 the heath hen was extinct, and she felt guilty about not having helped save the bird. When she heard about the plight of the greater prairie-chicken in the Midwest, she and her

TO FORUM

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new husband left their privileged lives in Boston and spent the next 40 years in the wilds of Wisconsin, doing what they could to save them.

NANCY BUTLER
Austin, Texas

Mother Bear Man

What a wonderful surprise to see your article about Ben Kilham's work with orphaned bear cubs. I had seen the Geographic's EXPLORER programs featuring Kilham and have been on the lookout for additional information ever since. I'm also thrilled to hear of his upcoming book, *Among the Bears* (Henry Holt and Company). I have great respect for what he's doing.

KATHI CHIANGO
Bedford, Massachusetts

I thought the article on Ben Kilham and his bears was fascinating, but it left me wondering: If he had to chomp on Indian cucumber to teach the bears to eat it, how did he teach them to eat moose and deer scat?

DANIEL FREIBERG
Wausau, Wisconsin

Happily, cubs figure that out on their own.

Solo Across the Arctic

I understand that on his solo trek Børge Ousland met others along the way who may have taken photos of him. But who took the picture of him swimming?

JEFF GREEN
Nutley, New Jersey

Ousland replies: The swimming photos are from video I took of myself. I put the camera on the edge of the ice, swam across the lead, and swam back to get it.

I will be the last to make light of the rigors of Børge Ousland's journey. But pardon me if I am not impressed by the dangers he faced or the hardships, injuries, and weight loss he suffered during the course of his journey. I would hail him as a hero had these been the result of service to his fellowman. As it is, he deliberately subjected himself to all of this only to claim his own brand of a world record.

BRIAN FEICHO
Granite City, Illinois

She left home, eloped with an oil rigger, moved to Taos, New Mexico, and opened a gem and mineral shop. She rejected the affluent environment she was raised in and discovered life. She used to say, "You can't eat a diamond."

Golden Age Treasures

When I read about the marble eye that was found, I remembered a story that an old Maltese fisherman told me about the eyes painted or fixed on ships. According to him all the seagoing nations around the Mediterranean preferred eyes on their ships to repel someone with a so-called evil eye, who could do harm. Until this day fishermen will not sail without this protection.

SANDRA WIERING
Spijkenisse, the Netherlands

ZipUSA: Murfreesboro, Arkansas

Winifred Parker, my first cousin, found a 15.3-carat diamond, named the Star of Arkansas, back in 1956. She was a rock collector and stumbled upon the diamond while looking for other minerals. Brought up in Dallas high society, Winnie would upset her parents by insisting upon eating in the kitchen with the maids. She left home, eloped with an oil rigger, moved to Taos, New Mexico, and opened a gem and mineral shop. She rejected the affluent environment she was raised in and discovered life. She used to say, "You can't eat a diamond."

ROBIN C. RUPE
Albuquerque, New Mexico

Ask Us

Your statement that "Earth's gravitational force on the moon is much stronger than the moon's tide-producing pull on Earth" would have Isaac Newton flinching in his grave. Every force has an equal and opposite reaction. The moon and Earth pull on each other absolutely evenly. You also refer to the moon's center of mass "bulging." While the center of mass may move, it is a mathematical point only; nothing physical "bulges." Yes, the moon is egg-shaped, with one side having more *mass* than the other. Having more mass, that side experiences a stronger force from Earth's gravity. The Earth does not pull "more strongly on the heavier side." It pulls more on the more *massive* side.

TOPHER WARING
Science Department Chair,
Lake Region Union High School
Orleans, Vermont

See the USA the walking Way

Some Ideas for Summer Vacation

The historic sites of the United States open windows onto America's past and provide a rich mosaic of the people and places that shaped the heritage of our great country. This summer, the best way to catch the spirit of the red, white, and blue is to walk the very ground where history happened. ★ Expand your horizons—read on to develop your own personal walking agenda. Walking regularly will put you on the road to better health, especially if you suffer from the pain of arthritis.

Join us now as we take "Historic Walks" to some of America's most beautiful and fascinating historic places.

You'll also learn how the Arthritis Foundation can help you take control of your arthritis and enhance your enjoyment of the wonderful sites and historic places in your own city and local neighborhoods. For a free Walking and Arthritis brochure, call the Arthritis Foundation toll free at 1-800-283-7800.

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Take Control. We Can Help.™

A message from the Arthritis Foundation

Take Steps to Control Arthritis

*As arthritis surges to epidemic proportions (**1 in 5** of us will have arthritis by the year 2020), the mission of the Arthritis Foundation—to prevent, control, and cure arthritis and related diseases—has never been more important.*

Whether you have been diagnosed with arthritis, are experiencing joint pain, or aren't yet showing signs of the disease, you'll discover that you can do something—such as walking—to protect your joints and limit pain and disability. Walking strengthens your muscles and helps maintain joint flexibility, both of which are critical to good joint health.

With 150 local offices across America, the Arthritis Foundation is the only not-for-profit organization helping people take control of their arthritis. Through your local Arthritis Foundation chapter, you can take advantage of a variety of local programs and services designed to help you take control and improve your quality of life.

Call the Arthritis Foundation toll-free at 1-800-283-7800 or visit www.arthritis.org for a FREE booklet, "51 Ways to be Good to Your Joints."

Take control. We can help!

Sincerely,

Tino J. Mantella
President/CEO
Arthritis Foundation

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Take Control. We Can Help.™

See the [illegible]

The marvelous sense of discovery that comes from walking vacations allows you to visit interesting places that you've only read about, transforming you from an armchair traveler into an active traveler. On a walking vacation, you can visit historic places across the United States, experiencing sites that have shaped our country's rich history, such as Philadelphia's Liberty Bell, Colonial Williamsburg, and many more. Add to that excitement a healthy dose of exercise, relaxation, and fresh air, and you have all the makings of a perfect vacation!

Visit a new place—explore on foot instead of on a tour bus

Walking vacations afford you many sightseeing luxuries, not the least of which is the ability to slow down to admire a landmark a little more closely or take in the beauty of a magnificent sunset. So instead of hurrying through a city, take things at your own leisurely pace with a walking tour. After all, isn't that what a vacation is all about?

Walking works wonders

Whether you're on vacation or staying home, walking is one of the best exercises there is. In addition to helping control arthritis symptoms, walking can also help you:

- *Ease arthritis pain*
- *Cut your risk of heart disease*
- *Control blood pressure*
- *Lower your risk of diabetes*
- *Build your bones*
- *Lose weight*

Go to www.nationalgeographic.com/walkingtours to obtain information on regional tours and create your own personal walking agenda.

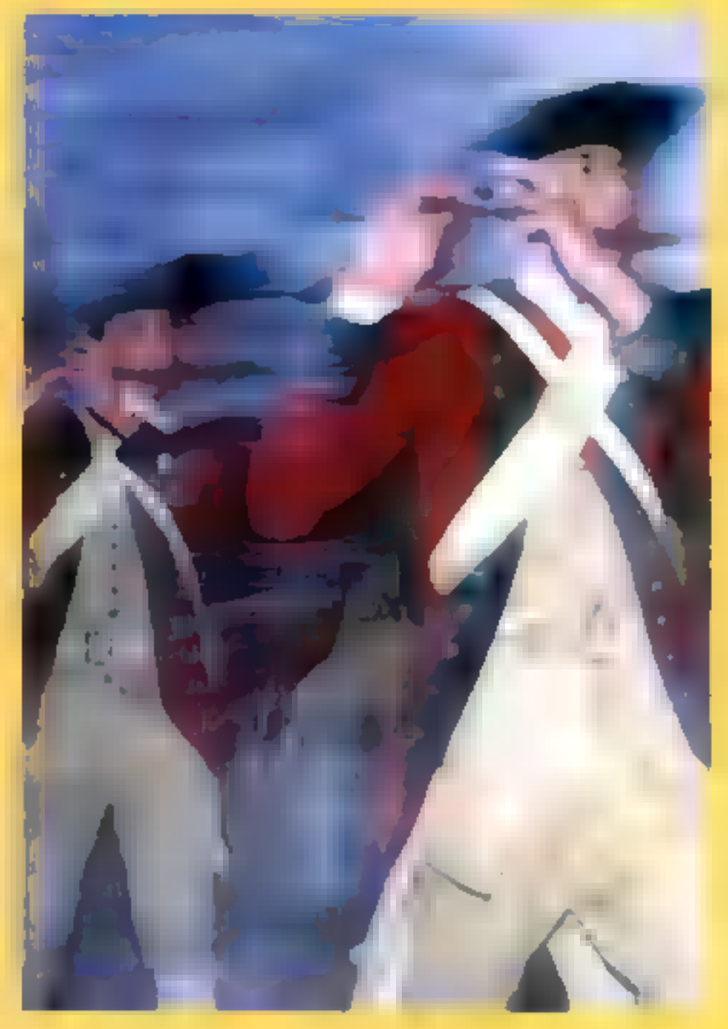
Mount Rushmore

Monumental patriotism

Gazing over the Black Hills, the four stone presidents—Washington, Jefferson, Lincoln, and Theodore Roosevelt—appear larger than life both in their physical stature (Lincoln's nose is 20 feet tall) and in their flag-waving symbolism. Sculptor Gutzon Borglum and his team blasted, drilled, and hammered away at the granite mountain to carve the busts, hauling away nearly a half million tons of rock with steadfast determination. The sculpture honors the courage of four great men who helped model the United States.

Trails: *Hike the Presidential Trail for the closest access to the structure, visit Borglum's studio to learn about how the monument was constructed, or take the short trail to the viewing terrace, where you can see the presidential quartet in one fell swoop.*

For more information: 1-800-732-5682 www.NPS.gov/moru



Colonial Williamsburg

Colonist for a day

It's the eve of the American Revolution and you're on Duke of Gloucester Street in Virginia's capital city, magically in the thick of it all. Patriots are abuzz over a radical idea called democracy while soldiers march in tri-cornered hats and military musicians play fifes and drums. And yet life goes on—mop-capped wenches serve peanut soup at Raleigh Tavern, the local bum is in the stocks, and the bake shop smells of its famous gingerbread. They're all reenactments in this picturesque living-history village, of course, but oh, how convincing they are.

Colonial Williamsburg *is a 173-acre living-history museum of Virginia's 18th-century capital. Eighty original and hundreds of replicated colonial structures line one-mile-long Duke of Gloucester and side streets, making it the perfect place to stroll into the past.*

For more information: 1-800-246-2099 www.colonialwilliamsburg.com

Freedom Trail

Cradle of American liberty

Following the patriots who fought for American independence, the Freedom Trail delves into quaint Boston neighborhoods—taking in centuries of history and 16 freedom-related sites along the way. Pop into the Old South Meeting House, where Patrick Henry roused angry colonists to join in the Boston Tea Party; poke around the Old North Church, where two lanterns were hung to warn that the British were coming "by sea"; stop by Faneuil Hall, where colonists first protested the sugar tax. You can't help but feel the fervor that changed America forever.

Freedom Trail: *Begin the 2.5-mile trail either at Boston Common or the Charlestown Navy Yard. Red painted lines or red bricks mark the route. The visitor information centers at Boston Common and the Bunker Hill Memorial have maps and information.*

For more information: 1-888-SeeBoston www.thefreedomtrail.org

Consult your doctor before beginning any exercise program.

Simple stretches to get you started

The best time to stretch is after five to 10 minutes of moderate walking and at the end of your walk.

These three moves target the calf and the front of the hip.

Stretch #1. Stand with your hands against a wall. Slide your right leg back two or three feet and lean forward onto your left leg, knee bent. To stretch the right calf, straighten the right leg, press the heel downward, and let the hip come forward. Hold for 30 seconds.

Stretch #2. Hold the position from Stretch #1 and bend your right knee just past the point at which you begin to feel the stretch. Hold for 30 seconds. Keep your heel pressing downward as your knee bends.

Stretch #3. Next, release your hands, place them on your hips, and lift your torso to upright. If you have trouble balancing, turn sideways to the bench or wall and hold on. Come up on the toes of your right foot, bend both knees slightly, and slowly tilt your pelvis by gently scooping your buttocks under and tightening your lower abdominal muscles until you feel a stretch at the front of your right hip. The more you tilt, the more you'll stretch. Hold for 30 seconds. Repeat all three stretches with the other leg.

Walking can help you manage arthritis pain

Walking is great exercise for people with arthritis. Here are some tips for pain-free walking:

- *Walk regularly, three to five times a week, for 20 to 30 minutes—all at once or in several shorter sessions.*
- *Time workouts for when you feel best. Your body will tell you if you're energized in the morning or less stiff in the afternoon.*
- *Walk at your own pace. Everyone has a walking speed that suits him or her best, so find one that's comfortable for you.*

Maintain muscle strength with walking

Exercise protects joints by strengthening the muscles around them, and strong muscles keep your joints from rubbing against one another, wearing down cartilage. Walking is an especially good exercise if you have arthritis: It's an aerobic exercise, which means it strengthens your heart, helps your lungs work more efficiently, and gives you more stamina so you don't tire as easily. As a weight-bearing exercise (one that puts full weight on your bones), walking helps strengthen bones, reducing the risk of osteoporosis (thinning of the bones). For people with arthritis, muscle and joint benefits are important because joints become stiffer and muscles weaken with inactivity. As walking strengthens the muscles and tissues surrounding the joints, it helps to better protect those joints and keep them ready for daily activities.

Walking made easier—shoes for the road

To get the most out of your workouts, you need a shoe that's specially designed for walking. Your shoes should have flexible and nonsticky soles that absorb shock well, with good arch supports, cushioned insoles, and roomy toe boxes. And make sure that your walking shoes fit correctly: If your socks wear through in the toes, your shoes are either too short or your foot is sliding forward with each step. It's a good idea to wear your walking socks when you go to purchase your shoes to help you get a better fit.

- *Tip: You can reduce your risk of injury by replacing your walking shoes every 330 to 600 miles.*

National Mall

Monumental city

As twilight falls in the nation's capital, marble monuments along the mall take on a radiant glow against the blue sky. These great memorials—Washington, Jefferson, Lincoln—declare that you stand at the heart of the world's greatest democracy. But what makes this especially poignant are the two other buildings—the White House, the president's residence, and the U.S. Capitol, where the laws of the land are created. Strolling among these towering American icons, you can't help but feel awed by the power and freedom they represent.

National Mall: *Walk from the Capitol, on First Street, between Independence and Constitution Avenues, west along the mall's pathways, past the Washington Monument and the White House. Make a loop by circling the Jefferson Memorial and returning to the Capitol along the opposite side of the mall.*

For more information: 1-800-422-8644 www.washington.org

Old Philadelphia

Where America was born

Amble Old Philadelphia's streets, where nearly every building tells a story of how America was born. Thomas Jefferson labored over the words to sum up the colonists' assertions of freedom at Declaration House and the Founding Fathers approved the document at Independence Hall. The most visited site is the Liberty Bell Pavilion, whose cracked bronze occupant clanged the nation's founding. The most stirring site, perhaps, is the house where Betsy Ross sewed the first Stars and Stripes. Her dedication epitomizes the way ordinary citizens devoted themselves to the fight for liberty. That's the true story of how America was born.

Independence National Historical Park: *More than 20 buildings illuminating the early history of America animate this historic jewel. Begin your walk at the visitor center at 3rd and Chestnut Sts., which has maps and information.*

For more information: 1-800-537-7676 www.gophila.com

Statue of Liberty & Ellis Island

Enlightening the world

Standing so tiny in New York Harbor, looming gigantic in the American psyche, Lady Liberty has greeted thousands of immigrants to America with the exhilarating promise of freedom and hope. Climb 354 steep, spiraling, metal stairs to her crown and a bird's-eye view of Lower Manhattan. A short jaunt away, beautifully restored Ellis Island delves into the nitty-gritty of the immigrants' first few days in their new life, their new world.

Statue of Liberty & Ellis Island: *Ferries depart regularly to both the Statue of Liberty and Ellis Island from Battery Park in Lower Manhattan. Purchase tickets at the Castle Clinton National Memorial.*

For more information: 1-800-Call-NYS www.NPS.gov

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MERCK

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In clinical studies, when taking daily VIOXX significantly reduced pain and stiffness. So VIOXX can help make it easier for you to do the things you want to do. Like going out for an early morning walk with a friend.

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VIOXX doesn't need to be taken with food. So, you don't have to worry about scheduling VIOXX around meals.

IMPORTANT INFORMATION ABOUT VIOXX.

In rare cases, serious stomach problems, such as bleeding, can occur without warning. People with allergic reactions, such as asthma, to aspirin or other arthritis medicines should not take VIOXX.

Tell your doctor if you have liver or kidney problems, or are pregnant. Also, VIOXX should not be used by women in late pregnancy.

VIOXX has been extensively studied in [illegible] clinical trials. Commonly reported side effects included upper respiratory infection, diarrhea, nausea and high blood pressure. Report any unusual symptoms to your doctor.

ASK YOUR DOCTOR OR HEALTHCARE PROFESSIONAL ABOUT VIOXX.

Call 1-800-MERCK-10 for more information, or visit www.vioxx.com. Please see important additional information on the next page.

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for Osteoarthritis and Pain
Generic name: rofecoxib ("ro-fa-COX-ib")

You should read this information before you start taking VIOXX*. Also, read the leaflet each time you refill your prescription, in case any information has changed. This leaflet provides only a summary of certain information about VIOXX. Your doctor or pharmacist can give you an additional leaflet that is written for health professionals that contains more complete information. This leaflet does not take the place of careful discussions with your doctor. You and your doctor should discuss VIOXX when you start taking your medicine and at regular checkups.

What is VIOXX?

VIOXX is a nonsteroidal anti-inflammatory drug (NSAID) that is used to reduce pain and inflammation (swelling and soreness). VIOXX is available as a tablet or a liquid that you take by mouth.

VIOXX is a medicine for:
- relief of osteoarthritis (the arthritis caused by age-related "wear and tear" on bones and joints)
- management of acute pain in adults (like the short-term pain you can get after a dental or surgical operation)
- treatment of menstrual pain (pain during women's monthly periods).

Who should not take VIOXX?

Do not take VIOXX if you:
- have had an allergic reaction such as asthma attacks, hives, or swelling of the throat and face to aspirin or other NSAIDs (for example, ibuprofen and naproxen).
- have had an allergic reaction to rofecoxib, which is the active ingredient of VIOXX, or to any of its inactive ingredients. (See Inactive Ingredients at the end of this leaflet.)

What should I tell my doctor before and during treatment with VIOXX?

Tell your doctor if you are:
- pregnant or plan to become pregnant. VIOXX should not be used in late pregnancy because it may harm the fetus.
- breast-feeding or plan to breast-feed. It is not known whether VIOXX is passed through to human breast milk and what its effects could be on a nursing child.

Tell your doctor if you have:
- kidney disease
- liver disease
- heart failure
- high blood pressure
- had an allergic reaction to aspirin or other NSAIDs
- had a serious stomach problem in the past.

Tell your doctor about:
- any other medical problems or allergies you have now or have had.
- all medicines that you are taking or plan to take, even those you can get without a prescription.

Tell your doctor if you develop:
- ulcer or bleeding symptoms (for instance, stomach burning or black stools, which are signs of possible stomach bleeding).
- unexplained weight gain or swelling of the feet and/or legs.
- skin rash or allergic reactions. If you have a severe allergic reaction, get medical help right away.

How should I take VIOXX?

VIOXX should be taken once a day. Your doctor will decide what dose of VIOXX you should take and how long you should take it. You may take VIOXX with or without food.

Can I take VIOXX with other medicines?

Tell your doctor about all of the other medicines you are taking or plan to take while you are on VIOXX, even other medicines that you can get without a prescription. Your doctor may want to check that your medicines are working properly together if you are taking other medicines such as:
- methotrexate (a medicine used to suppress the immune system)
- warfarin (a blood thinner)
- rifampin (an antibiotic)
- ACE inhibitors (medicines used for high blood pressure and heart failure)
- lithium (a medicine used to treat a certain type of depression).

*Registered trademark of MERCK & CO., Inc.

What are the possible side effects of VIOXX?

Serious but rare side effects that have been reported in patients taking VIOXX and/or related medicines have included:

- Serious stomach problems, such as stomach and intestinal bleeding, can occur with or without warning symptoms. These problems, if severe, could lead to hospitalization or death. Although this happens rarely, you should watch for signs that you may have this serious side effect and tell your doctor right away.
- Serious allergic reactions including swelling of the face, lips, tongue, and/or throat which may cause difficulty breathing or swallowing and wheezing occur rarely but may require treatment right away. Severe skin reactions have also been reported.
- Serious kidney problems occur rarely, including acute kidney failure and worsening of chronic kidney failure.
- Severe liver problems, including hepatitis, jaundice and liver failure, occur rarely in patients taking NSAIDs, including VIOXX. Tell your doctor if you develop symptoms of liver problems. These include nausea, tiredness, itching, tenderness in the right upper abdomen, and flu-like symptoms.

In addition, the following side effects have been reported: anxiety, confusion, depression, hair loss, hallucinations, increased [illegible] of potassium in the blood, low blood cell counts, palpitations, pancreatitis, tingling sensation, unusual headache with stiff neck (aseptic meningitis), vertigo.

More common, but less serious side effects reported with VIOXX have included the following:

Upper and/or lower respiratory infection and/or inflammation
Headache
Dizziness
Diarrhea
Nausea and/or vomiting
Heartburn, stomach pain and upset
Swelling of the legs and/or feet
High blood pressure
Back pain
Tiredness
Urinary tract infection.

These side effects were reported in at least 2% of osteoarthritis patients receiving daily doses of VIOXX 12.5 mg to 25 mg in clinical studies.

The side effects described above do not include all of the side effects reported with VIOXX. Do not rely on this leaflet alone for information about side effects. Your doctor or pharmacist can discuss with you a more complete list of side effects. Any time you have a medical problem you think may be related to VIOXX, talk to your doctor.

What else can I do to help manage my osteoarthritis pain?

Talk to your doctor about:
- Exercise
- Controlling your weight
- Hot and cold treatments
- Using support devices.

What else should I know about VIOXX?

This leaflet provides a summary of certain information about VIOXX. If you have any questions or concerns about VIOXX, osteoarthritis or pain, talk to your health professional. Your pharmacist can give you an additional leaflet that is written for health professionals.

Do not share VIOXX with anyone else; it was prescribed only for you. It should be taken only for the condition for which it was prescribed.

Keep VIOXX and all medicines out of the reach of children.

Inactive Ingredients:

Oral suspension: citric acid (monohydrate), sodium citrate (dihydrate), sorbitol solution, strawberry flavor, xanthan gum, sodium methylparaben, sodium propylparaben.

Tablets: croscarmellose sodium, hydroxypropyl cellulose, lactose, magnesium stearate, microcrystalline cellulose, and yellow ferric oxide.

Issued July 2001

MERCK & CO., Inc.
Whitehouse Station, NJ 08889, USA 20110386(8)(904)-VIO-CON

If You Have a General Claim, or a Claim for Asbestos-Containing Products in Your Residence or Building Manufactured or Sold by the Companies Listed Below:

USG Corporation
United States Gypsum Company
USG Interiors, Inc.
USG Interiors International, Inc.
L&W Supply Corporation
Beadex Manufacturing, LLC
B-R Pipeline Company
La Mirada Products Co., Inc.
USG Industries, Inc.
USG Pipeline Company
Stocking Specialists, Inc.

YOU MUST FILE A CLAIM BY JANUARY 15, 2003

The United States Bankruptcy Court for the District of Delaware (the "Court") has established **January 15, 2003**, as the general claims bar date (the "General Bar Date") in the chapter 11 cases of the companies listed above (the "Debtors"). All entities, including governmental units, that wish to assert any claims against the Debtors are required to file proofs of claim on or before 5:00 p.m., Eastern Time, on **January 15, 2003**.

Who Must File a Proof of Claim

The General Bar Date applies to all "General Claims," which are claims of any kind against the Debtors that arose before June 25, 2001, except asbestos-related personal injury claims. General Claims include Asbestos-Related Property Damage Claims. The definition of an Asbestos-Related Property Damage Claim, as well as other important information and definitions, may be obtained from the USG Claims Website listed below.

If you wish to assert a General Claim against any Debtor, including any Asbestos-Related Property Damage Claim, you must file a proof of claim by **January 15, 2003**.

Additional Information

- Additional information about the claims process and the General Bar Date may be obtained from the USG Claims Website, the USG Claims Helpline, or the Claims and Noticing Agent listed below.
- Certain of the Debtors manufactured or sold, at various times from the late 1920s through the late 1970s, a number of products that contained asbestos. These products include some acoustical plasters, some wall and ceiling plasters, spray fireproofing, fire-rated ceiling tiles, decorative textures, joint compound, and industrial insulation. For more information regarding the Debtors and products containing asbestos that may have been sold by the Debtors, please refer to www.usgclaims.com.

Procedure for Filing Proofs of Claims

- If you wish to assert an Asbestos-Related Property Damage Claim, you must use the Debtors' proof of claim form for Asbestos-Related Property Damage Claims.
- If you wish to assert a General Claim other than an Asbestos-Related Property Damage Claim, you may use Official Bankruptcy Form No. 10. You may not use Official Bankruptcy Form No. 10 to file an Asbestos-Related Property Damage Claim.

These forms can be downloaded from the USG Claims Website, or obtained by calling the USG Claims Helpline listed below.

A signed original of a completed proof of claim form, together with any supporting documentation, must be delivered to the Debtors' Claims and Noticing Agent: **Logan & Company, Inc., 546 Valley Road, Upper Montclair, New Jersey 07043, Attention: USG Claims Processing Department**, so as to be received not later than 5:00 p.m., Eastern Time, on **January 15, 2003**. The proof of claim form may be submitted in person, by courier service, hand delivery, or mail addressed to the Claims and Noticing Agent. Any proof of claim submitted by facsimile or e-mail will not be accepted and will not be deemed filed.

Consequences of Failure to File a Proof of Claim

Any entity that fails to file a proof of claim by **January 15, 2003**, as required by the Court's order establishing the General Bar Date and the procedures outlined in this notice, shall be forever barred, estopped, and enjoined from asserting any General Claim, including any Asbestos-Related Property Damage Claim, against the Debtors; or voting upon, or receiving any distributions under any plan or plans of reorganization in these chapter 11 cases in respect of such General Claims.

Failure to use the Asbestos-Related Property Damage Claim Form to assert an Asbestos-Related Property Damage Claim, or failure to include all of the information and documentation required by that proof of claim form, may lead to such claim being barred even if it was filed prior to **January 15, 2003**.

You may wish to consult an attorney regarding this matter.

For complete information, including all relevant forms, notices, and instructions, please consult:

USG Claims Website
www.usgclaims.com

USG Claims Helpline
1-866-233-9048

Write to: **USG Claims Processing Dept., Logan & Company, Inc., 546 Valley Rd., Upper Montclair, NJ 07043**

CONSERVATION

Can Hunting Save Lions?

Concern over the future of Africa's most iconic cat prompted officials in Botswana last year to ban all lion hunting there. The move sparked a predictable outcry from big-game hunters around the world, but even some wildlife biologists are wondering whether the blanket ban—which applies to hard-pressed livestock farmers as well as affluent trophy hunters—will do more harm than good.

"I'm not in favor of a total ban," says Paul Funston of South Africa's Endangered Wildlife Trust. "The real solution lies in giving the local people incentives to tolerate lions on their land."

Funston recently completed a three-year study of lions in Kgalagadi Transfrontier Park, which spans the borders of Botswana and South Africa. Local trackers helped locate lions, some of which were fitted with radio collars (right). Young males like these three (above) routinely roamed beyond the park and sometimes killed livestock on neighboring farms. Funston found that out of a total population of 675 lions that live in and around the park, farmers killed 93 (including these skins, far right) between 1997 and early 2001, or about 3 percent a year. "Our research shows that the population is healthy and this rate seems sustainable," he says.

Instead of maintaining the ban on lion hunting, Funston believes Botswana's government should allow trophy hunters to kill some lions that habitually raid livestock. Fees paid by the hunters would go to the farmers.

APHICA

CREATURES OF OUR UNIVERSE

ALL BY [redacted] FUNSTON

TECHNOLOGY

Maya Paint: Made to Last

ENRICO FERORELLI

The ancient Maya really loved the blues. Now researchers have solved the mystery of why that color in their paintings—as in this detail (right) from Mexico's Bonampak murals—has stayed so bright over the centuries.

According to Lori Polette of the University of Texas at El Paso, the Maya first heated their clay-and-indigo-based blue paint, causing an interaction that fused the two ingredients together. The resulting pigment is not only durable, it is also environmentally benign. This old technique, says Polette, has modern applications. Paint companies are interested in the newfound Maya technology for every color of the rainbow.

MICHAEL NICHOLS, NGS PHOTOGRAPHER

BIOLOGY

Three of a Kind

Only two species of elephants exist: Asian elephants and African elephants. Or so it was thought. Scientists in Kenya and at the National Cancer Institute (NCI) in Maryland studied genes of Africa's savanna elephants and forest elephants, once believed closely related. So different were the results that forest elephants (above) were declared a separate species. "There are only about 150,000 of them, and a lot of their habitat is very fragmented," says NCI geneticist Al Roca.

ALMANAC

July

When winter arrives in Australia, so does the breeding season for short-beaked echidnas. As many as ten males at once may pursue a female. Later she curls up and lays one egg into a pouch on her belly—which is why echidnas are called monotremes, or egg-laying mammals (platypuses likewise).

ART BY [redacted] HYNES

MORE [redacted] OUR WEBSITE

Find links and resources selected by our Research Division at **nationalgeographic.com/ngm/resources/0207.**

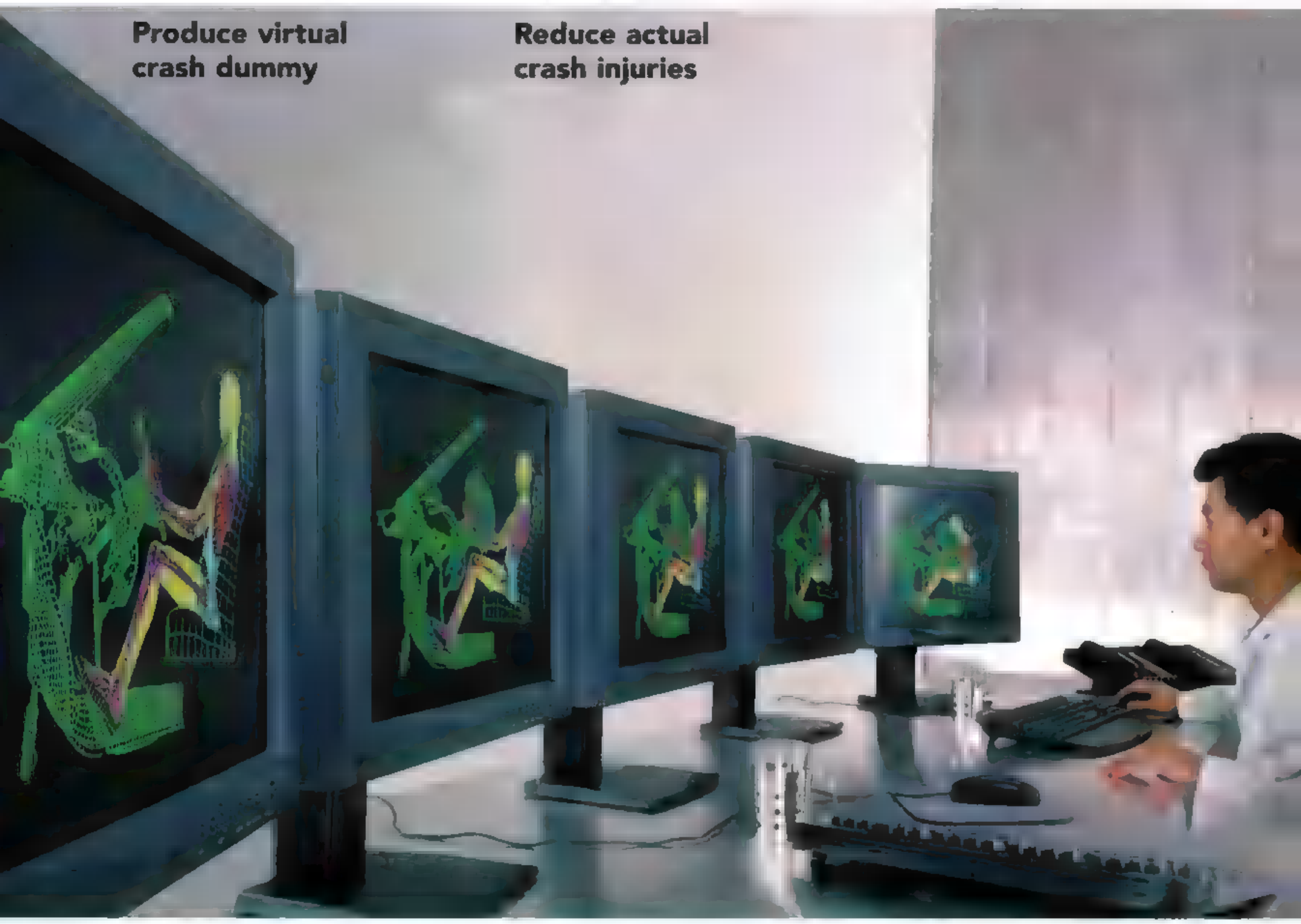
TODAY

Produce virtual crash dummy

TOMORROW

Reduce actual crash injuries

TOYOTA



He may be the most important "person" in automotive safety testing today. He's THUMS, the world's first virtual human for crash testing.

By analyzing data from THUMS' 80,000 cyberparts, Toyota engineers can now zero in on skin, bones, even tendons.

Although currently only an experiment, technologies like THUMS may one day be used to supplement our existing safety programs. Safer cars — thanks to one very smart dummy.

www.toyota.com/tomorrow

ECOLOGY

Spawn of a Hurricane?

Tropical lionfish a mystery off U.S. coast

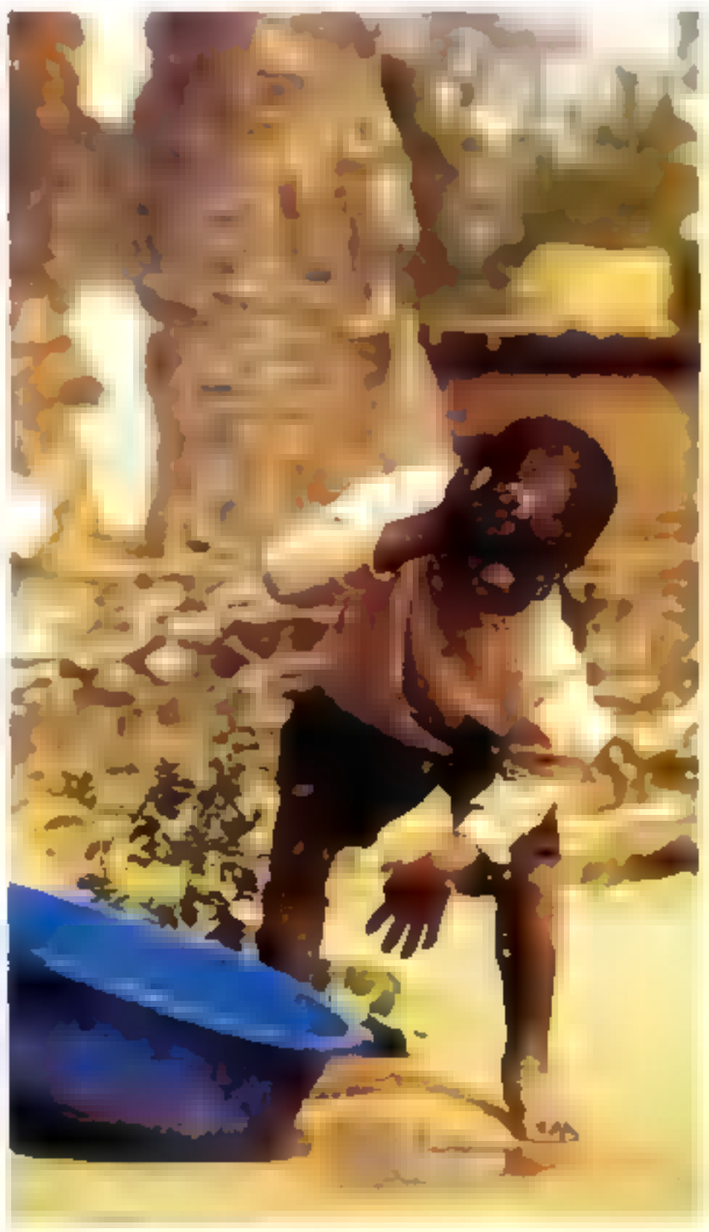
JONATHAN BIRD

Sporting a wild mane of venomous spines, lionfish live only in tropical Indo-Pacific seas. Or so it was thought.

Now, according to biologist Paula Whitfield, there are at least 19 in the waters off North Carolina. In August 2000 divers sighted two lionfish near a shipwreck 40 miles off the coast; the rest of the fish are scattered, including this one (right), which was found near another wreck. The species has also been spotted off Florida, Georgia, South Carolina, Long Island, and Bermuda. There is a remote chance that lionfish eggs, larvae, or juveniles were released from the ballast water of a ship. But Whitfield's principal theory goes back to 1992, when Hurricane Andrew slammed into Florida.

The culprit may have been an aquarium. At least one on Biscayne Bay was broken in the storm surge, and six lionfish were swept into the sea. "Eggs and larvae could have been carried 800 miles to North Carolina's Outer Banks," Whitfield says.

Whitfield and officials of the National Oceanic and Atmospheric Administration urge divers to be cautious, since these beauties are poisonous.



KHAMIS RAMADHAN

MEDICINE

Eyes to the Future

The world's leading cause of preventable blindness—for which more than 10 percent of the planet's population is at risk—could be eradicated entirely by 2020. Thanks to a donation of antibiotics from the drug company Pfizer and a worldwide push by the International Trachoma Initiative to distribute and administer the cure, one of mankind's oldest and most debilitating diseases could soon be a problem of the past.

Trachoma is an easily spread infection, especially common in families with young children. Repeated occurrences over the years scar the upper eyelid, eventually turning it inward. The eyelashes then scratch the cornea, leading to blindness.

Though it has blinded about six million people worldwide, most in developing countries, trachoma can be controlled with a single dose of an antibiotic used in conjunction with frequent face washing in clean water, as practiced by this Tanzanian boy (left).

If you and your partner are experiencing a decline in sexual activity, it may be the result of erection difficulties, such as erectile dysfunction (ED). Fact is, ED is a common health condition. It can be caused by factors such as high blood pressure, high cholesterol, diabetes, even stress. Fortunately, there is a proven treatment—VIAGRA. **More than 9 million men** have already turned to it.

So talk to him. He needs your support because it's not just about sex. It's about his health, too.

For more information, call 1-888-4VIAGRA or visit www.viagra.com.

VIAGRA®
(sildenafil citrate) tablets

Join the millions. Have him ask his doctor about a free sample.

VIAGRA is indicated for the treatment of erectile dysfunction. Remember that no medicine is for everyone. If you use nitrate drugs, often used to control chest pain (also known as angina), don't take VIAGRA. This combination could cause your blood pressure to drop to an unsafe or life-threatening level.

Discuss your general health status with your doctor to ensure that you are healthy enough to engage in sexual activity. If you experience chest pain, nausea, or any other discomforts during sex or an erection that lasts longer than 4 hours, seek immediate medical help. The most common side effects of VIAGRA are headache, facial flushing, and upset stomach. Less commonly, bluish vision, blurred vision, or sensitivity to light may briefly occur.

Please see patient summary of information for VIAGRA *(25-mg, 50-mg, 100-mg) tablets on the following page.*

Join the millions

PATIENT [redacted] OF INFORMATION ABOUT

VIAGRA®
(sildenafil citrate) tablets

This summary contains important information about VIAGRA®. It is not meant to take the place of your doctor's instructions. Read this information carefully before you start taking VIAGRA. Ask your doctor or pharmacist if you [redacted] not understand any of this information or if you want to know more about VIAGRA.

This medicine can help many men when it is used as prescribed by their doctors. However, VIAGRA is not for everyone. It is intended for use only by men who have a condition called erectile dysfunction. **VIAGRA must never be used by men who [redacted] taking medicines that contain nitrates of any kind, at any time. This includes nitroglycerin. If you take VIAGRA with any nitrate medicine your blood pressure could suddenly drop to an unsafe or life threatening level.**

[redacted] Is VIAGRA?

VIAGRA is a pill used to treat erectile dysfunction (impotence) in men. It can help many men who have erectile dysfunction get and keep [redacted] erection when they become sexually excited (stimulated).

You will not get an erection just by taking this medicine. VIAGRA helps a man with erectile dysfunction get [redacted] erection only when he is sexually excited.

How Sex Affects the Body

When a man is sexually excited, the penis rapidly fills with more blood than usual. The penis then expands and hardens. This is called an erection. After the man is done having sex, this extra blood flows out of the penis back into the body. The erection goes away. If an erection lasts for a long time (more than 6 hours), it can permanently damage your penis. You should call [redacted] doctor immediately if you ever have a prolonged erection that lasts more than 4 hours.

Some conditions and medicines interfere with this natural erection process. The penis cannot fill with enough blood. The man cannot have [redacted] erection. This is called erectile dysfunction [redacted] it becomes a frequent problem.

During sex, your heart works harder. Therefore sexual activity may not be advisable for people who have heart problems. Before you start any treatment for erectile dysfunction, ask your doctor if your heart is healthy enough to handle the extra strain of having sex. If you have chest pains, dizziness or nausea during sex, stop having sex and immediately tell your doctor you have had this problem.

How [redacted] Works

VIAGRA enables many men with erectile dysfunction to respond [redacted] sexual stimulation. When a man is sexually excited, VIAGRA helps the penis fill with enough blood [redacted] an erection. After sex is over, the erection goes away.

[redacted] Is [redacted] for Everyone

As noted above (*How Sex Affects the Body*), ask your doctor if your heart is healthy enough for sexual activity.

If you take any medicines that contain nitrates–either regularly or as needed–you should never take VIAGRA. If you take VIAGRA with any nitrate medicine or recreational drug containing nitrates, your blood pressure could suddenly drop to an unsafe level. You could get dizzy, faint, or even have a heart attack or stroke. Nitrates are found in many prescription medicines that are used to treat angina (chest pain due to heart disease) such [redacted]

- nitroglycerin (sprays, ointments, skin patches or pastes, and tablets that are swallowed or dissolved in the mouth)
- isosorbide mononitrate and isosorbide dinitrate (tablets [redacted] are swallowed, chewed, or dissolved in the mouth)

Nitrates are also found in recreational drugs such as amyl nitrate or nitrite ("poppers"). If you are not sure if any of your medicines contain nitrates, [redacted] if you do not understand what nitrates are, ask your doctor [redacted] pharmacist.

VIAGRA is only for patients with erectile dysfunction. VIAGRA is not for newborns, children, or women. Do not let anyone else take your VIAGRA. VIAGRA must be used only under a doctor's supervision.

What [redacted] Does Not [redacted]

- VIAGRA does not cure erectile dysfunction. It [redacted] a treatment for erectile dysfunction.
- VIAGRA does not protect you or your partner from getting sexually transmitted diseases, including HIV–the virus that [redacted] AIDS.
- VIAGRA is not a hormone or an aphrodisiac.

[redacted] To Tell Your Doctor Before You Begin [redacted]

Only your doctor can decide if VIAGRA is right for you. VIAGRA can cause mild, temporary lowering of your blood pressure. You will need to have a thorough medical exam to diagnose your erectile dysfunction and to find out if you [redacted] safely take VIAGRA alone or with your other medicines. Your doctor should determine if your heart is healthy enough to handle the extra strain of having [redacted]

Be sure to tell your doctor if you:

- have ever had any heart problems (e.g., angina, chest pain, heart failure, irregular heart beats, or heart attack)
- have ever had [redacted] stroke
- have low or high blood pressure
- have [redacted] rare inherited eye disease called retinitis pigmentosa
- have ever had any kidney problems
- have ever had any liver problems
- have ever had any blood problems, including sickle cell anemia or leukemia
- are allergic [redacted] sildenafil [redacted] any of the other ingredients of VIAGRA tablets
- have a deformed penis, Peyronie's disease, or ever had [redacted] erection that lasted more than 4 hours
- have stomach ulcers or any types of bleeding problems
- are taking any other medicines

[redacted] and Other Medicines

Some medicines can change the way VIAGRA works. Tell your doctor about **any medicines** you are taking. Do not start or stop taking any medicines before checking with your doctor or pharmacist. This includes prescription and nonprescription medicines or remedies. Remember, VIAGRA should never be used with medicines that contain nitrates (see *VIAGRA Is Not for Everyone*). If you are taking [redacted] protease inhibitor, your dose may be adjusted (please [redacted] *Finding the Right Dose for You*.) VIAGRA should not [redacted] used with any other medical treatments that cause erections. These treatments include pills, medicines that are injected or inserted into the penis, implants or vacuum pumps.

Finding the Right Dose for You

VIAGRA comes [redacted] different doses (25 mg, 50 mg and 100 mg). If you do not get the results you expect, talk with your doctor. You and your doctor can determine the dose that works best for you.

- Do not take more VIAGRA than your doctor prescribes.
- If you think you need a larger dose of VIAGRA, check with your doctor.
- VIAGRA should not be taken more than once a day.

If you are older than age 65, or have serious liver or kidney problems, your doctor may start you at the lowest dose (25 mg) of VIAGRA. If you are taking protease inhibitors, such [redacted] for the treatment of HIV, your doctor may recommend [redacted] 25 mg dose and may limit you to a maximum single dose of 25 mg of VIAGRA in a 48 hour period.

How To Take [redacted]

Take VIAGRA about one hour before you plan to have sex. Beginning in about 30 minutes and for up to 4 hours, VIAGRA can help you get an erection if you are sexually excited. If you take VIAGRA after a high-fat meal (such as a cheeseburger and french fries), the medicine may take [redacted] little longer to start working. VIAGRA can help you get an erection when you are sexually excited. You will not get an erection just by taking the pill.

Possible Side Effects

Like all medicines, VIAGRA can cause some side effects. These effects are usually mild to moderate and usually don't last longer than [redacted] few hours. Some of these side effects are more likely to occur with higher doses. The most common side effects of VIAGRA are headache, flushing of the face, and upset stomach. Less common side effects that may occur are temporary changes in color vision (such as trouble telling the difference between blue and green objects or having a blue color tinge to them), eyes being more sensitive to light, or blurred vision.

In [redacted] instances, men have reported an erection that lasts many hours. You should call a doctor immediately if you ever have an erection that lasts more than 4 hours. If not treated right away, permanent damage to your penis could occur (see *How Sex Affects the Body*).

Heart attack, stroke, irregular heart beats, and death have been reported rarely in men taking VIAGRA. Most, but not all, of these men had heart problems before taking this medicine. [redacted] is not possible to determine whether these events were directly related to VIAGRA.

VIAGRA may [redacted] other side effects besides those listed on this sheet. If you want more information or develop any side effects or symptoms you are concerned about, call your doctor.

Accidental Overdose

[redacted] case of accidental overdose, call your doctor right away.

Storing [redacted]

Keep VIAGRA out of [redacted] reach of children. Keep VIAGRA in its original container. Store at room temperature, 59°-86°F (15°-30°C).

For More Information on [redacted]

VIAGRA is a prescription medicine used to treat erectile dysfunction. Only your doctor can decide if it is right for you. This sheet is only a summary. If you have any questions [redacted] want more information about VIAGRA, talk with your doctor or pharmacist, visit www.viagra.com, or call 1-888-4VIAGRA.

Rev. 4, June 1999

VIAGRA®
(sildenafil citrate) tablets

HC144A01D The blue diamond tablet shape is a trademark of Pfizer Inc. U.S. Pharmaceuticals

Is it gas? Is it electric? Yes.

What's this, you say? A car powered by gasoline and electricity? Why?

An important question, with a simple answer: Because Honda is at it again.

The arrival of the Civic Hybrid represents nothing less than the future of high-efficiency automotive technology. But then, Honda has a long tradition of making history this way.

And how did a company known for gasoline efficiency do it this time? With electricity. The Civic Hybrid uses an electric motor to boost the power of its 4-cylinder aluminum engine. Honda engineers also found a way to recharge the electric motor's batteries during braking and decelerating, so the car never needs to be plugged in.

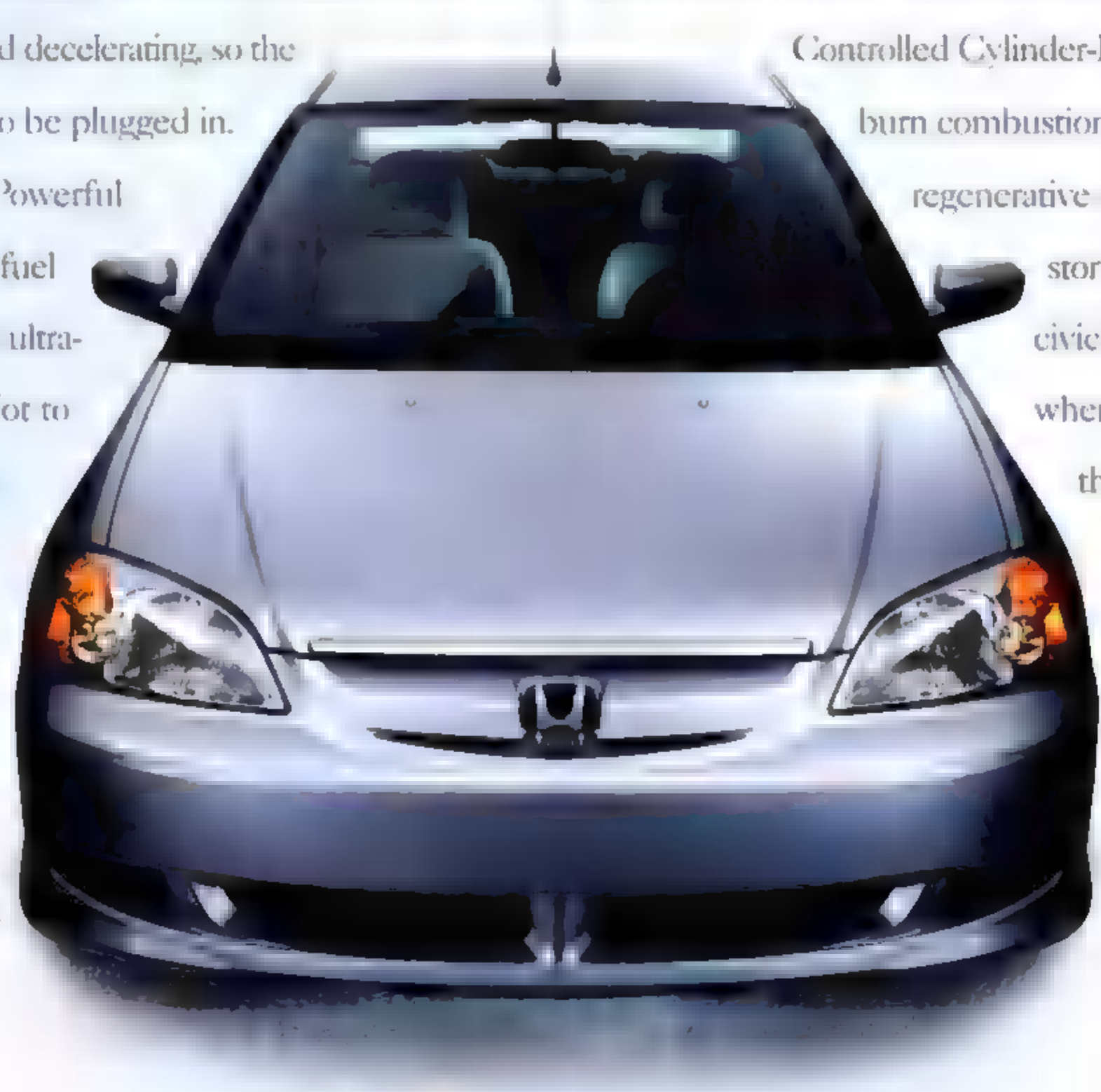
The result? Powerful acceleration, less fuel consumption and ultra-low emissions. Not to mention 46 mpg city and 51 highway,* the best highway fuel economy in the world for a five-passenger vehicle.

Fill up the tank, and you can go over 650 miles before needing to do it again.

Of course, what's on the outside counts too, so the Civic Hybrid is graced with sleek lines—and a 0.28 coefficient of drag, making it one of the world's most aerodynamic sedans. You'll find a certain degree of sophistication inside as well, where chrome trim complements finely tailored seats and an electronic instrument display that monitors 23 vehicle systems.

Getting there in a Civic Hybrid is the same as in any other car—just turn the key and go. But how Honda arrived here is another story. One involving intelligent dual-sequential ignition, a VTEC™-Controlled Cylinder-Idling System, lean-burn combustion technology and regenerative braking. In short, a story better told at civichybrid.honda.com, where explanations of the car's abundant technologies await.

Yes, the Civic Hybrid is capable of doing more. And, needless to say, it's changing things.



HONDA

The new Civic Hybrid

honda.com 1-800-33-Honda *Based on EPA mileage estimates for Civic Hybrid with MT (46 mpg city/51 mpg highway). Actual mileage may vary. ©2002 American Honda Motor Co., Inc.

ARCHAEOLOGY

Portrait of a Famous Lady

Everybody knows the legend of Lady Godiva: the young wife of a greedy lord who rode naked through the streets of Coventry, England, to protest her husband's high taxes. But nobody knew what she might have looked like—until now.

Archaeologists excavating Coventry's first cathedral have discovered a stained-glass portrait of a beautiful blond woman (left). The image was found in the west window area of what was the nave—where the building's patrons would likely have been portrayed, according to Coventry archaeologist Margaret Rylatt. "We cannot be 100 percent sure," she admits, "but we know that Godiva was a benefactor of the cathedral, and it seems likely." Rylatt's team still has thousands of shards of glass to sift through. But even if they find more of this portrait, and even if it is Godiva, she will be clothed. Some revisionists propose that the noblewoman's "naked" ride meant only that she was not dressed in her finery.

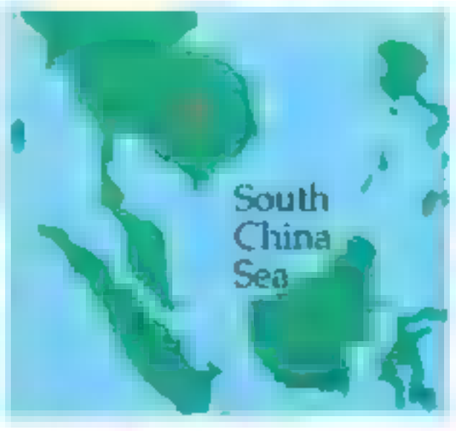
ANDREW FOX

Photographed by Allan Michaud

WILDLIFE AS CANON SEES IT

While feeding in a seasonal wetland, a lone giant ibis pauses momentarily to be vigilant. Singles, pairs or small groups return to roosting trees at night, flying almost unnoticed through the open canopy. Only a resounding bugling call reveals its presence at roost or in flight. The giant ibis has disappeared from most of its former Southeast Asia range, mainly from loss of habitat. However, a population has just been discovered in Cambodia's northern plains, a region that was inaccessible for decades, but is now open again to wildlife researchers. There is now new hope for this shy, unknown bird once thought to be nearing extinction.

As a global corporation committed to social and environmental concerns, we join in worldwide efforts to promote greater awareness of endangered species for the benefit of future generations.



Giant Ibis *(Thaumatibis gigantea)*
Size: Stands approx. 100 cm
Weight: Unknown, estimated at 2-4 kg
Habitat: Open lowland deciduous dipterocarp forests and wetlands in northern Cambodia and extreme southern Laos
Surviving number: Currently estimated at 100-200

NATURE

Watch NATURE on PBS. This program is funded in part by Canon.

Canon

Ford Windstar – Resume
The American [redacted]
Dearborn, MI 48126

Objective

To help keep [redacted] family [redacted] as the most

Employment history

I've [redacted] more than 1,566,370 [redacted] positions carrying [redacted] at [redacted], speaking in [redacted]

Special training

This is the [redacted] year in a row I've [redacted] the catastrophic five-star government [redacted] test rating. The government's highest (with optional [redacted] airbags).

Work-related initiatives

I was first in my market segment to offer lower anchors [redacted] tethers for children (LATCH), a safe and easy way to install child safety seats.

Special qualifications

With my Personal Safety System,™ I can determine things like how much to inflate the airbag (always wear your safety belt and secure children in the rear seat!).

I offer power mirrors that flash a signal when my sliding doors are open.

My available "conversation mirror" allows my driver to see behind while still looking forward.

Interests

Taking self-defense classes. Doing fitness training. Letting the kids enjoy my available AutoVision™ Video Entertainment System.

Reference

Rated by the National Highway Traffic Safety Administration

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www.fordvehicles.com

nobounderies

Ford

CONSERVATION

A Very Special Delivery

Rhino birth at Cincinnati Zoo first in 112 years

DAVID JENKINS, CINCINNATI ZOO AND BOTANICAL GARDEN

The Sumatran rhino is among the most endangered mammals on Earth. Only about 300 survive in the wild; just 15 exist in captivity. This hairier cousin of the bigger, armored rhinos is so rare that experts weren't even sure of its gestation period. Now they are.

On September 13, 2001, after five unsuccessful pregnancies—and 475 days' gestation—the Cincinnati Zoo's 11-year-old Sumatran, Emi, gave birth to Andalas, a 72-pound calf (above). He is the first of his species conceived and born in captivity since 1889.

Now topping 700 pounds, Andalas may go to a captive-breeding program in Indonesia or Malaysia. Information gained during Emi's closely watched pregnancy will aid such efforts.

ART BY RICHARD DOWNS

HEALTH

Sounds Dangerous

New research shows that loud noise doesn't only interfere with students' ability to hear the teacher. It also may contribute to a state of "learned helplessness," in which young children feel powerless over their environment and give up trying, putting them at greater risk for academic failure.

Tests conducted in schools near noisy airport flight paths show children performing worse on problem-solving tests than children in quieter areas. In another study, abilities rose after noise-abatement procedures were followed.

Problems with noise can come from within schools too. High ceilings and hard blackboards reverberate loud voices, bells, fire alarms, and even the lower decibel "white noise" of heating and cooling systems. Experts suggest installation of buffers such as carpet and acoustic tiles to help absorb loud noises—and increase learning.

CONSERVATION

Chesapeake Crabs: A Rally?

After lean years, cautious optimism in the bay

ROBERT W. MADDEN

Extolled by writer H. L. Mencken as an "immense protein factory," the Chesapeake Bay is undergoing a long overhaul to rid it of pollution and restore its renowned fisheries. Current focus: blue crabs. A decade ago the bay landed half the nation's annual catch. Now it's less than a third. But it's still the world's largest blue crab fishery, with 50 million pounds worth 55 million dollars a year.

To help the crabs recover, fishery officials have issued new regulations aimed at both reducing the harvest 15 percent by 2003 and doubling the number of crabs old enough to spawn. One of the rules limits watermen to an eight-hour workday.

Hopeful signs that the crabs are starting to make a comeback came last October with a windfall catch and large numbers of young crabs reported.

ASTRONOMY

Looking to the Skies

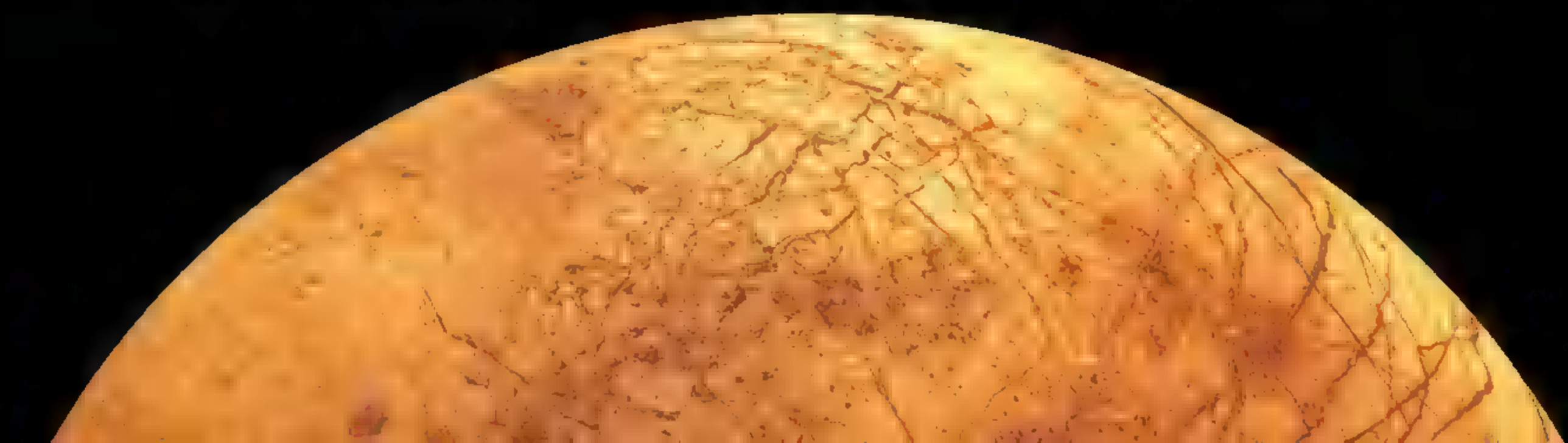
Stargazing Carnegie celebrates one hundred years

MARGARET BOURKE-WHITE, TIMEPIX; NASA (BELOW)

This year marks the centennial of the Carnegie Institution of Washington, D.C., the private nonprofit group founded by industrialist Andrew Carnegie to promote new discoveries in the sciences. Some of its most important finds have been out of this world. In 1919 the Carnegie hired Edwin Hubble (right), who first confirmed that celestial bodies known as nebulae were actually galaxies outside our own.

These days Carnegie scientists are looking for life beyond our planet, with recent studies concentrating on Jupiter's moons, including Europa (below). Microbiologist James Scott is one of the scientists investigating microbes that could survive on Europa's icy surface. "Most people think that life is impossible, but our work shows some life can survive," he says. "This has implications for how life might have started on Earth—and for finding life on other planets, such as Mars.

"I couldn't do this work alone," says Scott. "The greatest thing about the Carnegie is the collaboration. We have chemists and physicists and geologists and biologists all working together, all looking for answers—because we ask the big questions here."



Welcome to this season's Coach trunk show.

Pursuing the Lexus RX 300 Coach Edition. They say style is all about how you carry yourself. At Lexus, we wholeheartedly agree. Especially if you happen to be carrying yourself in the elegant RX 300 Coach Edition. The RX 300's smooth ride is made even more intelligent when paired with an Ivory Coach Edition leather-trimmed interior with perforated seats. Rich burl-eye maple embellishes both the steering wheel and the interior trim. And along with your RX 300 Coach Edition you'll receive two complimentary Coach bags—a large Hampton leather Cabin Bag and the new Signature Denim Pouch bursting in the exclusive Coach signature logo fabric with leather trim. So you can carry just about everything else in style, as well.

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Behind the SCENES

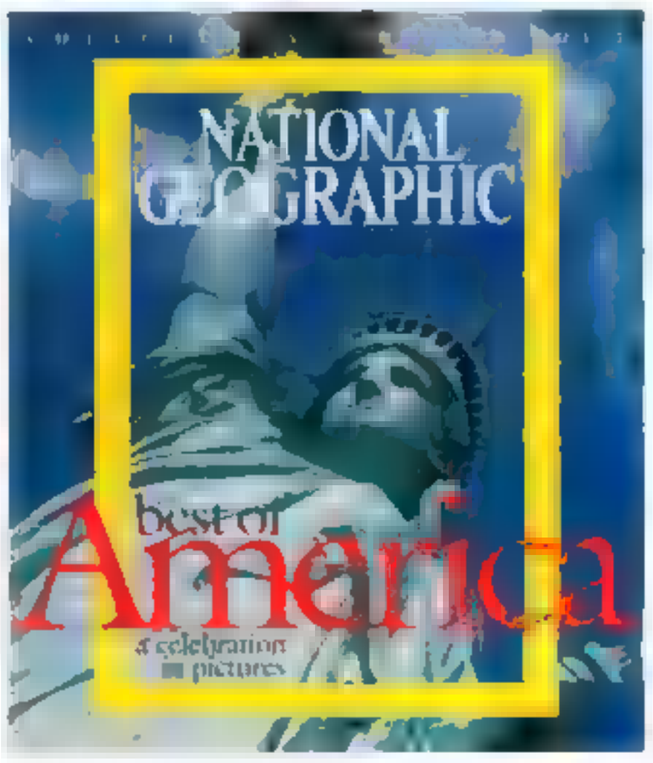
AT THE NATIONAL GEOGRAPHIC SOCIETY

Curious as Cats

When our photographers go out on assignment, their main purpose is to make photographs. But they often make friends and influence people too.

Steve Winter (right) spent months in Belize, working with researcher Carolyn Miller to track jaguars for an article that appeared in our May 2001 issue. While there, he also visited regularly with local schoolchildren (above, at the Belize Zoo). "Steve's stay has had a lasting influence," says Nancy Winckler-Zuñiga, then co-director of Gallon Jug Community School. "He made a point of asking every child he ran into what they knew about jaguars. They never understood before that someone would value their information. Once they knew that, it all came tumbling out."

America's Best



NATIONAL GEOGRAPHIC photographers and writers have found roadways into every imaginable kind of American community and made us all homesick for places we've never been before. Now many of their finest images and words have been brought together in *Best of America*, a special large-format issue of the magazine that arrives on newsstands and in bookstores this month. Editor Bill Allen calls the collector's edition a "salute to the people and landscapes that are the soul of the country." Priced at $9.95, the special issue can be ordered online at *nationalgeographic.com/ngm/bestamerica*, or call 1-800-777-2800 (toll free in the U.S. and Canada). Elsewhere call 1-813-979-6845.

DAVID S. BOYER

They will always fall before they fly

If my kids can do it the first time, they think it's too easy. That's why I insist on plastic safety gear. So pushing their limits is more of a challenge and less of a risk. I want my children to learn that being fearless doesn't [redacted] being stupid.

How have plastics touched your life?

American Plastics Council.

Plastics make it possible.

www.plastics.org

ANDRE FORBES

Putting Reading on the Map

Book drive links American teen, African students

The kids at Emfundweni Primary School in Zwide township, South Africa (above), have lots of reading to catch up on—38 years' worth, in fact. More than 400 back issues of NATIONAL GEOGRAPHIC from

JANET L. NIMLOS

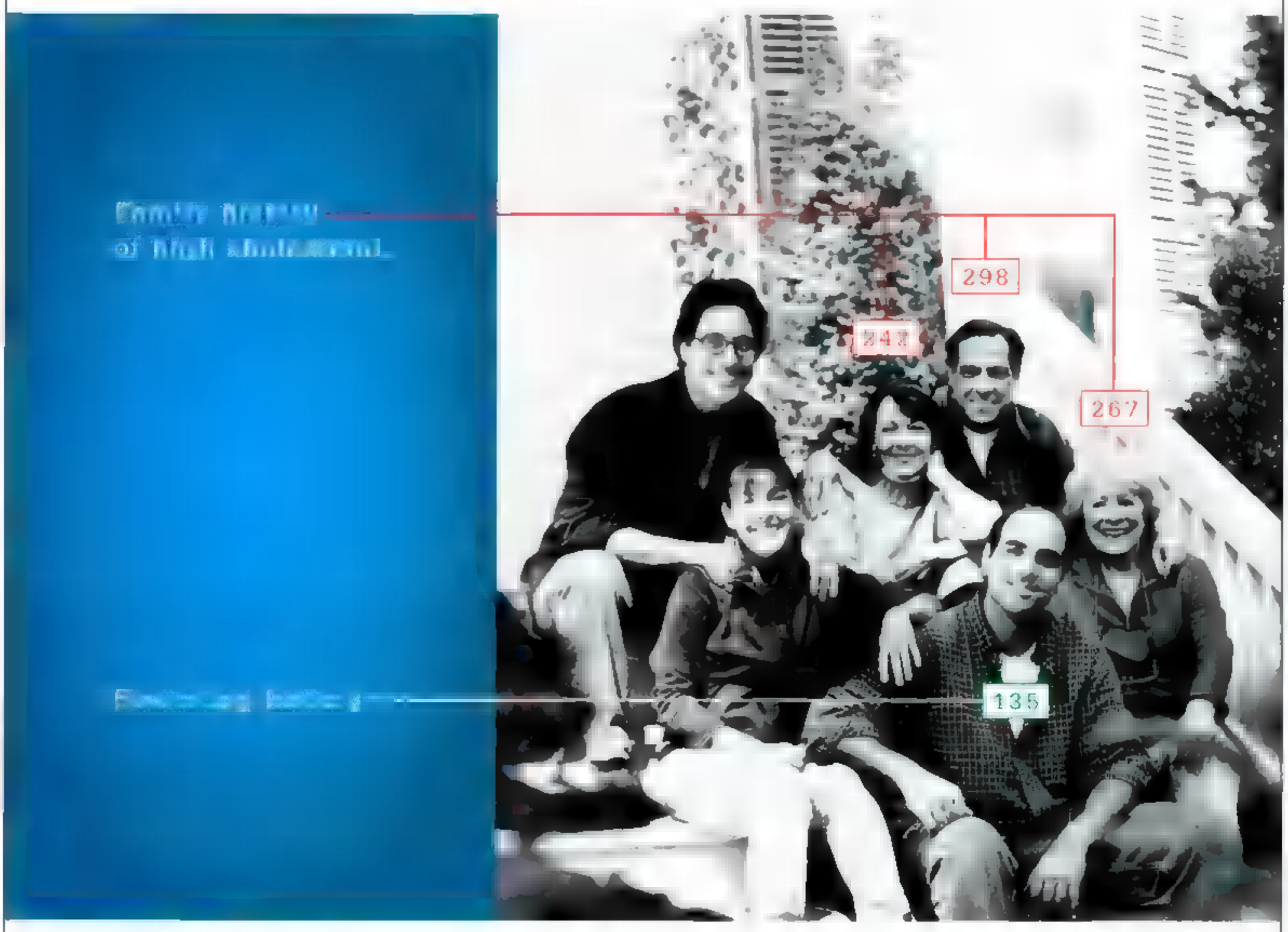
1963 to 2000 now fill several shelves in their school's new library. A plaque on the wall honors 19-year-old Marta Nimlos of Lake Forest Park, Washington, a suburb of Seattle. While in high school, Marta, now a student at the University of Victoria, British Columbia, launched a book drive for the school as a senior class project.

"I originally thought we'd get a few hundred books," says Marta, shown here with her father (below). "The response from the community was awesome."

Inspired by a teacher's report on the desperate needs of the schools in South Africa's black townships, Marta created a video and set out collection bins at her high school, a nearby elementary school, a bookstore, and her church. She ended up with more than 4,000 children's books, plus the GEOGRAPHICS. She then raised $1,600 to ship the lot to South Africa and an additional $1,500 that helped launch construction of a library building.

"Marta has touched the lives not only of children but also of parents, because they will come to school and read," said Andre Forbes, coordinator of a school development program in Zwide and other communities.

Marta declares that she is not finished yet: She hopes to raise money this summer to fund a new classroom at the school, which now has only 18 rooms for a thousand students.



Important information:

LIPITOR (atorvastatin calcium) is a prescription drug used with diet to lower cholesterol. LIPITOR is not for everyone, including those with liver disease or possible liver problems, women who are nursing, pregnant, or may become pregnant. LIPITOR has not been shown to prevent heart disease or heart attacks.

If you take LIPITOR, tell your doctor about any unusual muscle pain or weakness. This could be a sign of serious side effects. It is important to tell your doctor about any medications you are currently taking to avoid possible serious drug interactions. Your doctor may do simple blood tests to monitor liver function before and during drug treatment. The most commonly reported side effects are gas, constipation, stomach pain and indigestion. They are usually mild and tend to go away.

Please see additional important information on next page.

The bad news: high cholesterol may have as much to do with family genes as food. The good news: if diet and exercise aren't enough, adding LIPITOR can lower your total cholesterol 29% to 45% and your bad cholesterol 39% to 60% (average effect depending on dose). So shake up your tree a little. One in five people has high cholesterol and millions need treatment — talk to your doctor to find out if LIPITOR is right for you. To learn more, contact us at **1-888-LIPITOR** or **www.lipitor.com**.

LIPITOR
atorvastatin calcium
tablets

FOR CHOLESSTEROL™

LIPITOR® (Atorvastatin Calcium) Tablets
Brief Summary of Prescribing Information

CONTRAINDICATIONS: Active liver disease or unexplained persistent elevations of serum transaminases. Hypersensitivity to any component of this medication. **Pregnancy and Lactation** — Atherosclerosis is a chronic process and discontinuation of lipid-lowering drugs during pregnancy should have little impact on the outcome of long-term therapy in primary hypercholesterolemia. Cholesterol and other products of cholesterol biosynthesis are essential components for fetal development (including synthesis of steroids and cell membranes). Since HMG-CoA reductase inhibitors decrease cholesterol synthesis and possibly the synthesis of other biologically active substances derived from cholesterol, they may cause fetal harm when administered to pregnant women. Therefore, HMG-CoA reductase inhibitors are contraindicated during pregnancy and in nursing mothers. ATORVASTATIN SHOULD BE ADMINISTERED TO WOMEN OF CHILDBEARING AGE ONLY WHEN SUCH PATIENTS ARE HIGHLY UNLIKELY TO CONCEIVE AND HAVE BEEN INFORMED OF THE POTENTIAL HAZARDS. If the patient becomes pregnant while taking this drug, therapy should be discontinued and the patient apprised of the potential hazard to the fetus.

WARNINGS: Liver Dysfunction — HMG-CoA reductase inhibitors, like some other lipid-lowering therapies, have been associated with biochemical abnormalities of liver function. **Persistent elevations (>3 times the upper limit of normal (ULN) occurring on 2 or more occasions) in serum transaminases occurred in 0.7% of patients who received atorvastatin in clinical trials. The incidence of these abnormalities was 0.2%, 0.2%, 0.6%, and 2.3% for 10, 20, 40, and 80 mg, respectively.** One patient in clinical trials developed jaundice. Increases in liver function tests (LFT) in other patients were not associated with jaundice or other clinical signs or symptoms. Upon dose reduction, drug interruption, or discontinuation, transaminase levels returned to or approached pretreatment levels without sequelae. Eighteen of 30 patients with persistent LFT elevations continued treatment with a reduced dose of atorvastatin. **It is recommended that liver function tests be performed prior to and at 12 weeks following both the initiation of therapy and any elevation of dose, and periodically (eg, semiannually) thereafter.** Liver enzyme changes generally occur in the first 3 months of treatment with atorvastatin. Patients who develop increased transaminase levels should be monitored until the abnormalities resolve. Should an increase in ALT or AST of >3 times ULN persist, reduction of dose or withdrawal of atorvastatin is recommended. Atorvastatin should be used with caution in patients who consume substantial quantities of alcohol and/or have a history of liver disease. Active liver disease or unexplained persistent transaminase elevations are contraindications to the use of atorvastatin (see CONTRAINDICATIONS). **Skeletal Muscle — Rhabdomyolysis with acute renal failure secondary to myoglobinuria has been reported with other drugs in this class.** Uncomplicated myalgia has been reported in atorvastatin-treated patients (see ADVERSE REACTIONS). Myopathy, defined as muscle aches or muscle weakness in conjunction with increases in creatine phosphokinase (CPK) values >10 times ULN, should be considered in any patient with diffuse myalgias, muscle tenderness or weakness, and/or marked elevation of CPK. Patients should be advised to report promptly unexplained muscle pain, tenderness or weakness, particularly if accompanied by malaise or fever. Atorvastatin therapy should be discontinued if markedly elevated CPK levels occur or myopathy is diagnosed or suspected. The risk of myopathy during treatment with other drugs in this class is increased with concurrent administration of cyclosporine, fibric acid derivatives, erythromycin, niacin, or azole antifungals. Physicians considering combined therapy with atorvastatin and fibric acid derivatives, erythromycin, immunosuppressive drugs, azole antifungals, or lipid-lowering doses of niacin should carefully weigh the potential benefits and risks and should carefully monitor patients for any signs or symptoms of muscle pain, tenderness, or weakness, particularly during the initial months of therapy and during any periods of upward dosage titration of either drug. Periodic creatine phosphokinase (CPK) determinations may be considered in such situations, but there is no assurance that such monitoring will prevent the occurrence of severe myopathy. **Atorvastatin therapy should be temporarily withheld or discontinued in any patient with an acute, serious condition suggestive of a myopathy or having a risk factor predisposing to the development of renal failure secondary to rhabdomyolysis (eg, severe acute infection, hypotension, major surgery, trauma, severe metabolic, endocrine and electrolyte disorders, and uncontrolled seizures).**

PRECAUTIONS: General — Before instituting therapy with atorvastatin, an attempt should be made to control hypercholesterolemia with appropriate diet, exercise, and weight reduction in obese patients, and to treat other underlying medical problems (see INDICATIONS AND USAGE in full prescribing information). **Information for Patients** — Patients should be advised to report promptly unexplained muscle pain, tenderness, or weakness, particularly if accompanied by malaise or fever. **Drug Interactions** — The risk of myopathy during treatment with other drugs of this class is increased with concurrent administration of cyclosporine, fibric acid derivatives, niacin (nicotinic acid), erythromycin, azole antifungals (see WARNINGS, Skeletal Muscle). ***Antacid:*** When atorvastatin and Maalox® TC suspension were coadministered, plasma concentrations of atorvastatin decreased approximately 35%. However, LDL-C reduction was not altered. ***Antipyrine:*** Because atorvastatin does not affect the pharmacokinetics of antipyrine, interactions with other drugs metabolized via the same cytochrome isozymes are not expected. ***Colestipol:*** Plasma concentrations of atorvastatin decreased approximately 25% when colestipol and atorvastatin were coadministered. However, LDL-C reduction was greater when atorvastatin and colestipol were coadministered than when either drug was given alone. ***Cimetidine:*** Atorvastatin plasma concentrations and LDL-C reduction were not altered by coadministration of cimetidine. ***Digoxin:*** When multiple doses of atorvastatin and digoxin were coadministered, steady-state plasma digoxin concentrations increased by approximately 20%. Patients taking digoxin should be monitored appropriately. ***Erythromycin:*** In healthy individuals, plasma concentrations of atorvastatin increased approximately 40% with coadministration of atorvastatin and erythromycin, a known inhibitor of cytochrome P450 3A4 (see WARNINGS, Skeletal Muscle). ***Oral Contraceptives:*** Coadministration of atorvastatin and an oral contraceptive increased AUC values for norethindrone and ethinyl estradiol by approximately 30% and [illegible]. These increases should be considered when selecting an oral contraceptive for a woman taking atorvastatin. ***Warfarin:*** Atorvastatin had no clinically significant effect on prothrombin time when administered to patients receiving chronic warfarin treatment. **Endocrine Function** — HMG-CoA reductase inhibitors interfere with cholesterol synthesis and theoretically might blunt adrenal and/or gonadal steroid production. Clinical studies have shown that atorvastatin does not reduce basal plasma cortisol concentration or impair adrenal reserve. The effects of HMG-CoA reductase inhibitors on male fertility have not been studied in adequate numbers of patients. The effects, if any, on the pituitary-gonadal axis in premenopausal women are unknown. Caution should be exercised if an HMG-CoA reductase inhibitor is administered concomitantly with drugs that may decrease the levels or activity of endogenous steroid hormones, such as ketoconazole, spironolactone, and cimetidine. **CNS Toxicity** — Brain hemorrhage was seen in a female dog treated for 1 months at 120 mg/kg/day. Brain hemorrhage and optic nerve vacuolation were seen in another female dog that was sacrificed in moribund condition after 11 weeks of escalating doses up to 280 mg/kg/day. The 120 mg/kg dose resulted in a systemic exposure approximately 16 times the human plasma area-under-the-curve (AUC, 0-24 hours) based on the maximum human dose of 80 mg/day. A single tonic convulsion was seen in each of 2 male dogs (one treated at 10 mg/kg/day and one at 120 mg/kg/day) in a 2-year study. No CNS lesions have been observed in mice after chronic treatment for up to 2 years at doses up to 400 mg/kg/day or in rats at doses up to 100 mg/kg/day. These doses were 6 to 11 times (mouse) and 6 to 11 times (rat) the human AUC (0-24) based on the maximum recommended human dose of 80 mg/day. CNS vascular lesions, characterized by perivascular hemorrhages, edema, and mononuclear cell infiltration of perivascular spaces, have been observed in dogs treated with other members of this class. A chemically similar drug in this class produced optic nerve degeneration (Wallerian degeneration of retinogeniculate fibers) in clinically normal dogs in a dose-dependent fashion at a dose that produced plasma drug levels about 30 times higher than the mean drug level in humans taking the highest recommended dose. **Carcinogenesis, Mutagenesis, Impairment of Fertility** — In a 2-year carcinogenicity study in rats at dose levels of 10, 100 and 200 mg/kg/day, liver tumors were found in muscle in high-dose females. In one, there was a rhabdomyosarcoma and, in another, there was a fibrosarcoma. This dose represents a plasma AUC (0-24) value of approximately 9 times the mean human plasma drug exposure after an 80 mg oral dose. A 2-year carcinogenicity study in mice given 100, 200, or 400 mg/kg/day resulted in a significant increase in liver adenomas in high-dose males and liver carcinomas in high-dose females. These findings occurred at plasma AUC (0-24) values of approximately 6 times the mean human plasma drug exposure after an 80 mg oral dose. *In vitro*, atorvastatin was not mutagenic or clastogenic in the following tests with and without metabolic activation: the Ames test with *Salmonella typhimurium* and *Escherichia coli*, the HGPRT forward mutation assay in Chinese hamster lung cells, and the chromosomal aberration assay in Chinese hamster lung cells. Atorvastatin was negative in the *in vivo* mouse micronucleus test. Studies in rats performed at doses up to 175 mg/kg (15 times the human exposure) produced no changes in fertility.

There was aplasia and aspermia in the epididymis of 2 of 10 rats treated with 100 mg/kg/day of atorvastatin for 3 months (100 times the human AUC at the 80 mg dose), testis weights were significantly lower at 100 and 200 mg/kg and epididymal weight was lower at 100 mg/kg. Male rats given 100 mg/kg/day for 11 weeks prior to mating had decreased sperm motility, spermatid head concentration, and increased abnormal sperm. Atorvastatin caused no adverse effects on semen parameters, or reproductive organ histopathology in dogs given doses of 10, 40, or 120 mg/kg for two years. **Pregnancy — Pregnancy Category X: See CONTRAINDICATIONS.** Safety in pregnant women has not been established. Atorvastatin crosses the rat placenta and reaches a level in fetal liver equivalent to that of maternal plasma. Atorvastatin was not teratogenic in rats at doses up to 300 mg/kg/day or in rabbits at doses up to 100 mg/kg/day. These doses resulted in multiples of about 30 times (rat) or 6 times (rabbit) the human exposure based on surface area (mg/m²). In a study in rats given 20, 100, or 225 mg/kg/day, from gestation day 7 through to lactation day 21 (weaning), there was decreased pup survival at birth, neonate, weaning, and maturity in pups of mothers dosed with 225 mg/kg/day. Body weight was decreased on days 4 and 21 in pups of mothers dosed at 100 mg/kg/day; pup body weight was decreased at birth and at days 4, 21, and 91 at 225 mg/kg/day. Pup development was delayed (rotorod performance at 100 mg/kg/day and acoustic startle at 225 mg/kg/day; pinnae detachment and eye opening at 225 mg/kg/day). These doses correspond to 6 times (100 mg/kg) and 22 times (225 mg/kg) the human AUC at 80 mg/day. Rare reports of congenital anomalies have been received following intrauterine exposure to HMG-CoA reductase inhibitors. There has been a report of severe congenital bony deformity, tracheo-esophageal fistula, and anal atresia (VATER association) in a baby born to a woman who took lovastatin with dextroamphetamine sulfate during the first trimester of pregnancy. LIPITOR should be administered to women of childbearing potential only when such patients are highly unlikely to conceive and have been informed of the potential hazards. If the woman becomes pregnant while taking LIPITOR, it should be discontinued and the patient advised again as to the potential hazards to the fetus. **Nursing Mothers** — Nursing rats had plasma and liver drug levels of 50% and 40%, respectively, of that in their mother's milk. Because of the potential for adverse reactions in nursing infants, women taking LIPITOR should not breastfeed (see CONTRAINDICATIONS). **Pediatric Use** — Treatment experience in a pediatric population is limited to doses of LIPITOR up to 80 mg/day for 1 year in 8 patients with homozygous FH. No clinical or biochemical abnormalities were reported in these patients. None of these patients was below 8 years of age. **Geriatric Use** — Treatment experience in adults age ≥70 years with doses of LIPITOR 10 to 80 mg/day has been evaluated in 221 patients. The safety and efficacy of LIPITOR in this population were similar to those of patients <70 years of age.

ADVERSE REACTIONS: LIPITOR is generally well tolerated. Adverse reactions have usually been mild and transient. In controlled clinical trials of 2,502 patients, <2% of patients were discontinued due to adverse experiences attributable to atorvastatin. The most frequent adverse events thought to be related to atorvastatin were constipation, flatulence, dyspepsia, and abdominal pain. **Clinical Adverse Experiences** — Adverse experiences reported in ≥2% of patients in placebo-controlled clinical studies of atorvastatin, regardless of causality assessment, are shown in the following table:

Adverse Events in Placebo-Controlled Studies (% of Patients)

[illegible] SYSTEM Adverse Event	Placebo N = 270	Atorvastatin 10 mg N = 863	Atorvastatin 20 mg N = 38	Atorvastatin 40 mg N = 79	Atorvastatin 80 mg N = 94
BODY AS A WHOLE					
Infection	10.0	10.3	2.8	10.1	7.4
Headache	7.0	5.4	16.7	2.5	6.4
Accidental Injury	3.7	4.2	0.0	1.3	3.2
Flu Syndrome	1.9	2.2	0.0	2.5	3.2
Abdominal Pain	0.7	2.8	0.0	3.8	2.1
Back Pain	3.0	2.8	0.0	3.8	1.1
Allergic Reaction	2.6	0.9	2.8	1.3	0.0
Asthenia	1.9	2.2	0.0	3.8	0.0
DIGESTIVE SYSTEM					
Constipation	1.8	2.1	0.0	2.5	1.1
Diarrhea	1.5	2.7	0.0	3.8	5.3
Dyspepsia	4.1	2.3	2.8	1.3	2.1
Flatulence	3.3	2.1	2.8	1.3	1.1
RESPIRATORY SYSTEM					
Sinusitis	2.8	2.8	0.0	2.5	6.4
Pharyngitis	1.5	2.5	0.0	1.3	2.1
SKIN AND APPENDAGES					
Rash	0.7	3.9	2.8	[illegible]	1.1
MUSCULOSKELETAL SYSTEM					
Arthralgia	1.5	2.0	[illegible]	5.1	0.0
Myalgia	1.1	3.2	5.6	1.3	0.0

The following adverse events were reported, regardless of causality assessment in patients treated with [illegible] in clinical trials. The events in italics occurred in ≥2% of patients and the events in plain type occurred in <2% of patients.

Body as a Whole: Chest pain, face edema, fever, neck rigidity, malaise, photosensitivity reaction, generalized edema. ***Digestive System:*** Nausea, gastroenteritis, liver function tests abnormal, colitis, vomiting, gastritis, dry mouth, rectal hemorrhage, esophagitis, eructation, glossitis, mouth ulceration, anorexia, increased appetite, stomatitis, biliary pain, cheilitis, duodenal ulcer, dysphagia, enteritis, melena, gum hemorrhage, stomach ulcer, tenesmus, ulcerative stomatitis, hepatitis, pancreatitis, cholestatic jaundice. ***Respiratory System:*** Bronchitis, rhinitis, pneumonia, dyspnea, asthma, epistaxis. ***Nervous System:*** Insomnia, dizziness, paresthesia, somnolence, amnesia, abnormal dreams, libido decreased, emotional lability, incoordination, peripheral neuropathy, tachycardia, facial paralysis, hyperkinesia, depression, hypesthesia, hypertonia. ***Musculoskeletal System:*** Arthritis, leg cramps, bursitis, tenosynovitis, myasthenia, tendinous contracture, myositis. ***Skin and Appendages:*** Pruritus, contact dermatitis, alopecia, dry skin, sweating, acne, urticaria, eczema, seborrhea, skin ulcer. ***Urogenital System:*** Urinary tract infection, urinary frequency, cystitis, hematuria, impotence, dysuria, kidney calculus, nocturia, epididymitis, fibrocystic breast, vaginal hemorrhage, albuminuria, breast enlargement, metrorrhagia, nephritis, urinary incontinence, urinary retention, urinary urgency, abnormal ejaculation, uterine hemorrhage. ***Special Senses:*** Amblyopia, tinnitus, dry eyes, refraction disorder, eye hemorrhage, deafness, glaucoma, parosmia, taste loss, taste perversion. ***Cardiovascular System:*** Palpitation, vasodilatation, syncope, migraine, postural hypotension, phlebitis, arrhythmia, angina pectoris, hypertension. ***Metabolic and Nutritional Disorders:*** Peripheral edema, hyperglycemia, creatine phosphokinase increased, gout, weight gain, hypoglycemia. ***Hemic and Lymphatic System:*** Ecchymosis, anemia, lymphadenopathy, thrombocytopenia, petechia. ***Postintroduction Reports*** — Adverse events associated with LIPITOR therapy reported since market introduction, that are not listed above, regardless of causality assessment, include the following: anaphylaxis, angioneurotic edema, bullous rashes (including erythema multiforme, Stevens-Johnson syndrome, and toxic epidermal necrolysis), and rhabdomyolysis.

OVERDOSAGE: There is no specific treatment for atorvastatin overdosage. In the event of an overdose, the patient should be treated symptomatically, and supportive measures instituted as required. Due to extensive drug binding to plasma proteins, hemodialysis is not expected to significantly enhance atorvastatin clearance.

This summary provides important information about Lipitor. For more information, please ask your doctor, pharmacist or healthcare professional to provide the professional labeling and then discuss it with them.

℞ only

Pfizer U.S. Pharmaceuticals

LP106204-B

If You Own or Operate a Commercial, Residential or Public Building Constructed With Asbestos-Containing Products You May Have a Claim in the W. R. Grace Bankruptcy

Claims Must be Filed by March 31, 2003

W. R. Grace, its predecessors, subsidiaries, and other related entities ("Grace") have filed for protection under Chapter 11 of the U.S. Bankruptcy Code. The Bankruptcy Court has ordered that all individuals and entities with Asbestos Property Damage Claims against Grace must file these claims on or before March 31, 2003 ("Bar Date").

Who is Affected by this Notice?

Asbestos Property Damage Claimants
Individuals and entities that own or manage commercial, public and high-rise residential buildings that have asbestos-containing products may be affected including schools, hotels, government buildings, theaters, airports, churches, and other public facilities.

Asbestos Property Damage Claims include, among other claims, the cost of removal, the diminution of property value or economic loss, etc., caused by asbestos in products manufactured by Grace or from vermiculite mined, milled, processed, or sold by Grace.

What Types of Products are Involved?

Grace Asbestos-Containing Products
Grace produced and marketed vermiculite products containing added asbestos primarily to the commercial construction industry. From 1959 to 1973, Grace marketed Mono-Kote 3 (MK-3), an asbestos-containing, wet, spray–applied fireproofing product used to provide fire protection for the enclosed steel structures of large buildings. Other Grace products included Zonolite Acoustical Plastic, and other acoustical plasters and texture products used primarily on interior ceilings and walls.

Grace Vermiculite Products
Grace mined, produced and marketed vermiculite products, some of which may have contained naturally occurring asbestos. The products were sold to the building construction, agricultural/horticultural and consumer markets. These products included Monokote Fireproofing, Zonolite Concrete Roof Decks and Zonolite Masonry Insulation.

How Do I File a Claim?

To preserve your claim, you must file the appropriate Proof of Claim Form with the Claims Agent so that it is received by March 31, 2003. Failure to file a Proof of Claim Form by the Bar Date may result in your claim not being considered for payment.

This is a Summary Notice only. For complete information including the Claims Bar Date Notice, Proof of Claim Forms, instructions for filing a claim, a list of Grace asbestos-containing products, and a list of Grace entities write to: Claims Agent, Re: W. R. Grace & Co. Bankruptcy, P. O. Box 1620, Faribault, MN 55021-1620, or call:

1-800-432-1909 or visit www.graceclaims.com

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Stalking Amid Brilliance

A botany student pursues lilies and beetles in a sea of daisies in Namaqualand, South Africa. Check out other web-exclusive pictures from the article "The Big Bloom" at *nationalgeographic.com/ngm/0207* and net a photo for your collection.

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NATIONAL GEOGRAPHIC EXPLORER, MSNBC

Seeing the Story

"The human condition, that's what I want to show," says EXPLORER filmmaker Lawrence Cumbo. His interest in the tragedy of war took Cumbo this January to a Pakistan refugee camp. There he found clues that led him to the long-lost "Afghan girl"—Sharbat Gula, whose haunting, green-eyed portrait by photographer Steve McCurry appeared on the June 1985 cover of NATIONAL GEOGRAPHIC. *Search for the Afghan Girl* captured the world's attention—and won Cumbo the friendship of Sharbat's brother, Kashar Khan (left).

"My philosophy is to stay out of the way and document what I see," says Cumbo, who shoots and writes his own films. A Louisiana native, he overcame adversity in his own life, undergoing four eye operations as a child before he could see properly. His future plans: traveling to Nepal to see how doctors are giving sight to the blind.

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AskUs

THE ANSWER PLACE [illegible] Correspondence staff responds to questions from curious readers.

Q I've heard that vultures are disappearing in India. How is this affecting the Parsi tradition of depositing their dead to be eaten by the birds?
A The Parsis—whose Zoroastrian faith prohibits them from tainting earth, wind, or fire with their corpses—have for centuries exposed their dead to scavenging birds. India has lost more than 95 percent of its vultures in the past few decades, and scientists are not sure why. In Mumbai (Bombay) vultures no longer encircle the Parsis' hilltop Towers of Silence. The Parsis have enlisted the National Birds of Prey Centre in England to help them design [redacted] vulture breeding program, knowing that the local wild population may never return to the high numbers of the past. Meanwhile the Parsis must rely on the gradual effects of the elements to claim their dead—about three corpses [redacted] day—and are looking at other methods that fit their beliefs.

Q Which way does water flow in the Strait of Gibraltar?
A It flows east *and* west. The surface flow carries Atlantic water eastward into the Mediterranean Sea, where it is subjected to strong evaporation. The water's salinity increases, making it denser. It then sinks and returns to the Atlantic Ocean by flowing westward along the bottom of the strait.

Q Do all snakes have forked tongues?
A Yes. The constantly flicking dual tips gather odor molecules, allowing the reptiles to follow chemical "signposts" in their quest for prey, a mate, or the way home.

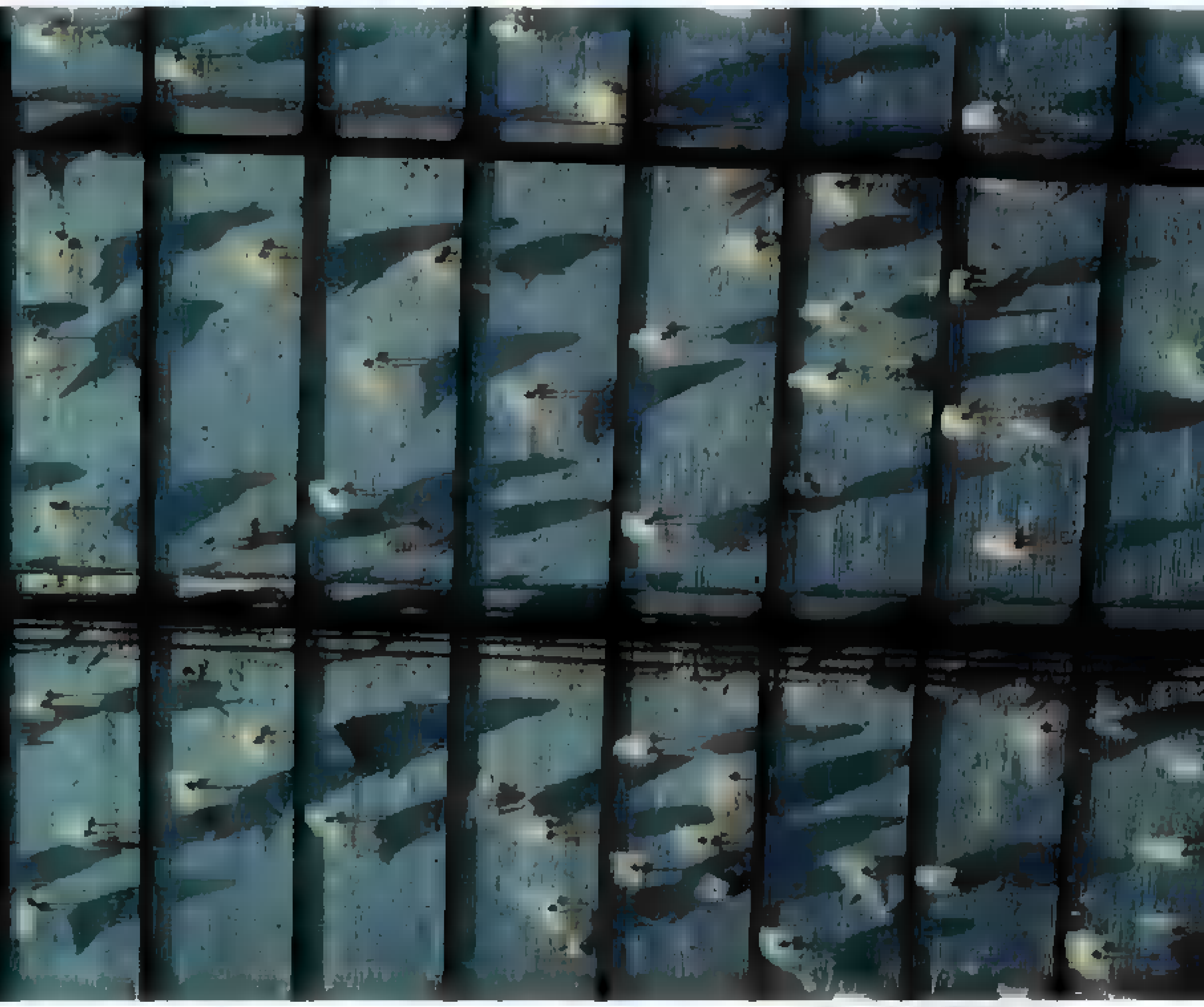
MORE INFORMATION
Send questions to **Ask Us, National Geographic Magazine, PO Box 98199, Washington, DC 20090-8199** or [redacted] the Internet to **ngsaskus@nationalgeographic.com**. Include name, address, and daytime phone number.

[illegible]

What peaceful creatures are roosting on this roof in Lisbon? Hint: It's not [illegible] you see.

[illegible] you know the answer? Go online [illegible] nationalgeographic.com/ngm/tellus/0207 and [illegible] or read [illegible] here in next month's issue.

June answer Many shellfish accumulate red pigment by [illegible] creatures that have [illegible] certain plankton or [illegible] pigment bonds with a protein in the shell, making [illegible] invisible until the heat of [illegible] breaks the [illegible] reveals the red.



NATE O. [redacted], ORION PHOTOS

HALF

THE LETHAL LEGACY OF AMERICA'S NUCLEAR WASTE

lurable radiation in one
enough to kill in minutes em-
anates from 11 [illegible] of spent
nuclear reactor fuel confined
in steel cylinders behind glass
walls at a government facility
in Idaho. The United States
is seeking a permanent reposi-
tory for such dangerous
wastes—just part of the U.S.
nuclear disposal problem.

LIFE

YUCCA MOUNTAIN, NV

Boot hill for the plutonium gang? The Bush administration's choice for high-level nuclear waste, Yucca Mountain has been studied for over 20 years by the Department of Energy at a cost of four billion dollars. The site could open around 2010—if DOE eludes a phalanx of environmentalists and Nevada officials

ROCKY FLATS, CO

Deep underground, armed guards patrol a cache of plutonium at Rocky Flats, a former weapons plant that closed in 1989. It had been designated a Superfund site three years earlier. Now the sprawling complex is being dismantled, its plutonium slated to move elsewhere.

By Michael E. Long
Photographs by Peter Essick

WORLD WAR II WAS still being fought in the Pacific during the first week of August 1945, a time when my father and I were vacationing in Atlantic City, New Jersey, eating soft-shell crabs and lazing by the ocean. In a games arcade I fed nickels to a toy machine gun and fired at Japanese Zero fighters flitting across a screen. On the boardwalk, rifles shouldered, platoons of United States soldiers marched and sang:

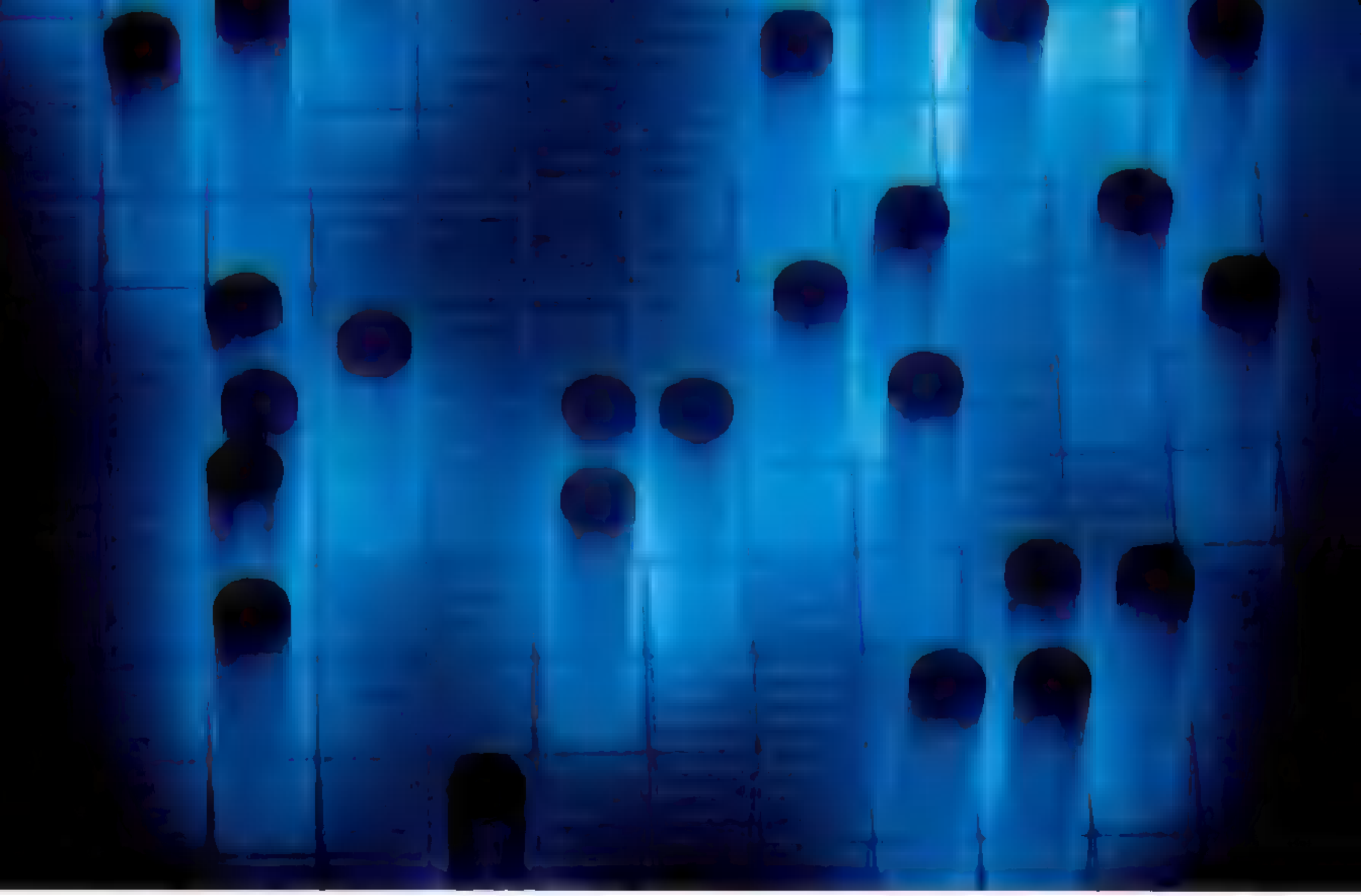
The Stars and Stripes will fly over Tokyo,
Fly over Tokyo, fly over Tokyo,
The Stars and Stripes will fly over Tokyo,
When the 991st gets there. . . .

One morning my dad showed me a newspaper with red headlines that said a huge bomb had been dropped on Hiroshima, Japan. Three days later another bomb was dropped on Nagasaki, and Japan surrendered. The bombs were so big that the boys of the 991st wouldn't have to go to Tokyo after all.

The strong nuclear force, the binding energy that makes atomic nuclei the most tightfisted entities in all creation, had been sundered, unleashing enormous power—the equivalent of 15,000 tons of TNT in the Hiroshima bomb—as well as a race to create bigger weapons. Seven years later our first hydrogen device, code-named Mike, yielded a blast equal to 10.4 million tons of TNT. Mike would have leveled all five boroughs of New York City.

By the mid-1960s, the height of the Cold War, the U.S. had stockpiled around 32,000 nuclear warheads, as well as mountains of radioactive garbage from the production of plutonium for these weapons. Just one kilogram, or 2.2 pounds, of plutonium required around a thousand tons of uranium ore. Generated from uranium bombarded by neutrons in a nuclear reactor, the plutonium was later separated from the uranium in hellish baths of acids and solvents still awaiting disposal.

A long-deferred cleanup is now under way at 114 of the nation's nuclear facilities, which encompass an acreage equivalent to Rhode Island and Delaware combined. Many smaller sites, the easy ones, have been cleansed, but the big challenges remain. What's to be done with 52,000 tons of dangerously radioactive spent fuel from commercial and defense nuclear



Painted ■ ghostly blue by radiation, water isolates cylinders of cesium and strontium—by-products of producing plutonium for nuclear weapons such as the Mace missile (facing page). Other than nuclear reactor cores, this pool at DOE's Hanford Site in Washington State is the nation's most lethal single source of radiation.

reactors? With 91 million gallons of high-level waste left over from plutonium processing, scores of tons of plutonium, more than half a million tons of depleted uranium, millions of cubic feet of contaminated tools, metal scraps, clothing, oils, solvents, and other waste? And with some 265 million tons of tailings from milling uranium ore—less than half stabilized —littering landscapes?

For an idea of scale: Load those tailings into railroad hopper cars, then pour the 91 million gallons of waste into tank cars, and you would have a mythical train that would reach around the Equator and then some.

In a decade real trains and trucks carrying high-level waste may head to Yucca Mountain, Nevada, the government's choice, and a controversial one, for a permanent repository.

In addition to storing the waste, contaminated soil and groundwater must be treated and stabilized, nuclear reactors decommissioned, buildings demolished, some buried waste exhumed, sorted, and buried again because it wasn't buried right in the first place. The bill for all this will be staggering—perhaps 400 billion dollars over 75 years.

Several federal agencies share the task. The Department of Energy (DOE) runs the facilities and supervises cleanup performed by commercial contractors. The Environmental Protection Agency (EPA) sets health and environmental standards for long-term storage of waste. Meanwhile the Department of Transportation supervises most shipments of nuclear materials using standards set by the Nuclear Regulatory Commission (NRC), which also licenses all except military reactors, which are—to come full circle—supervised by the Department of Energy.

I spent six weeks traveling to major nuclear facilities in several states, talking with managers, scientists, and engineers. Many cheerily took time to explain nuclear physics and radiation, but it took the Department of Energy more than four months to respond to an important question: How much nuclear waste in its various forms exists in the U.S.? (For the answer, see Types of Waste, page 14.)

I also spoke to environmentalists, who are

satisfied that a cleanup is finally taking place but suspicious whether it will be done to their standards. "The government," summed up one environmentalist, "will just lie to you."

In truth, our nation's nuclear weapons establishment operated in secret for many years, creating a deep vein of public distrust. As a result, emotions can run high when you're talking nuclear waste, weapons, and power. I'll state my bias now—as a former Marine Corps officer I value the profession of arms as honorable and necessary. I view nuclear weapons as a proven deterrent to war, not as a threat to peace. And I support the role of nuclear power in our energy mix. Yet during my reporting I found myself conceding points to environmentalists and even questioning government plans for permanent storage of high-level waste.

IT TOOK THE DEPARTMENT OF ENERGY MORE THAN FOUR MONTHS TO RESPOND TO AN IMPORTANT QUESTION: HOW MUCH NUCLEAR WASTE EXISTS IN THE U.S.?

CLEANING UP nuclear garbage would be a lot easier if we didn't have to face the chemical and physical chaos of health-threatening radiation, the emission of energy from a radioactive material.

Plutonium or cesium or strontium or other "-ium" elements created in a nuclear reactor emit dangerous radiation that can literally knock electrons off the atoms in our cells, disrupting or destroying cellular function or even causing cells to mutate. This radiation comes in the form of tiny alpha or beta particles or gamma rays traveling with great energy.

Radioactive elements emit radiation because they are unstable; they'd rather be something else. They achieve this by literally going to pieces; many emit particles and waves billions and billions of times each second.

Every radioactive element, including the -ium elements, has a half-life, the time it takes for half of its atoms to decay. Half-lives range from a fraction of a second to billions of years—4.5 billion for uranium 238. Paradoxically, the longer the half-life the less intense the radiation. Slightly radioactive uranium is no health threat if handled properly. After ten half-lives, an element is usually harmless.

Scientists quantify radiation received by people with a unit called a rem. A single whole-body dose of 400 rem, equivalent to more than 40,000 chest x-rays, will kill half the people receiving it. The maximum exposure permitted nuclear plant workers is 5 rem a year.

Everywhere, we experience background radiation, so-called because it's there all the time, mainly cosmic rays and alpha particles from radon gas. Other sources include medical x-rays, TV sets, even bricks, which pick up some uranium from the clay they're made of. Our bodies are slightly radioactive, mostly from everyday exposure to potassium.

The background radiation on a windswept Colorado mesa called Rocky Flats is around 450 millirem a year (a millirem is one thousandth of a rem), but the problem at a weapons plant there of the same name is big-league radioactivity from some of those -ium elements, principally plutonium. From 1952 to the end of the Cold War in 1989, technicians there fashioned chunks of plutonium into tens of thousands of spheres capable of triggering thermonuclear weapons.

Rocky Flats sits between Denver and Boulder and their galleries of critics who religiously chronicled tainted groundwater; drums oozing waste; plutonium-contaminated air ducts, pipes, and soil. Plutonium's nasty habit of being pyrophoric—igniting spontaneously—caused two major fires and myriad small ones, contributing to Rocky Flats' reputation as one of the most vilified weapons plants in the U.S.

Rockwell, the plant's contractor, eventually plea-bargained environmental crimes including acid spills and four other felonies and paid 18.5 million dollars in fines.

Today the buck of criticism stops at Barbara

Storage casks at the Prairie Island nuclear waste plant near Minneapolis (right and below) have nine inches of reinforced steel and hold 17.4 tons each of spent fuel assemblies. With the number of [illegible] casks limited to 17 by the state of Minnesota, the plant will run out of storage space in 2007.

Officials from eight nuclear power facilities, including Prairie Island, have signed a lease with tribal Native Americans to store spent fuel on their reservation in Skull Valley, Utah. "We'll get money for schools and a hospital," says tribal chairman Leon Bear [illegible], who supports the plan. If approved by the Nuclear Regulatory Commission, the 100-acre site would hold up to [illegible] tons of spent fuel.

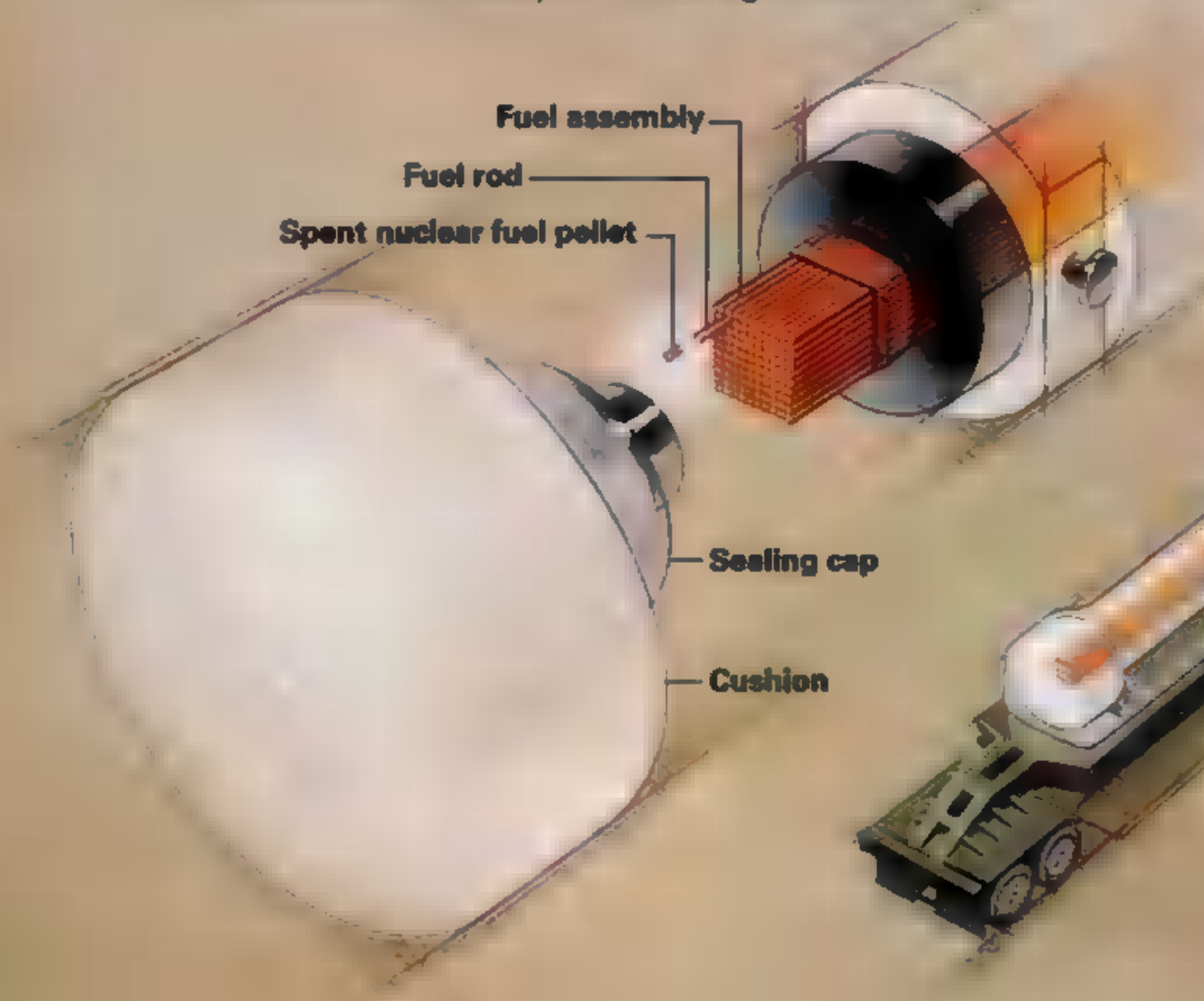
NUCLEAR WASTE
FROM BIRTH TO BURIAL

The detritus of the nuclear age includes 52,000 tons of spent fuel from commercial, military, and research reactors, as well as 91 million gallons of radioactive waste from plutonium processing. Most reactors lie east of the Mississippi River, guaranteeing a cross-country trip by road and rail to transport the high-level waste to the proposed 50-billion-dollar repository at Yucca Mountain, Nevada. Some 50 miles of tunnels in Yucca's volcanic tuff could hold 77,000 tons of waste. DOE has judged the site to be "scientifically sound," and President Bush approved it earlier this year. Hotly disagreeing, the state of Nevada exercised its right to veto, which Congress can override. Even with a go-ahead, DOE must prove the Yucca facility will meet EPA requirements that radiation be safely contained for 10,000 years.

THE ROUTE TO YUCCA MOUNTAIN

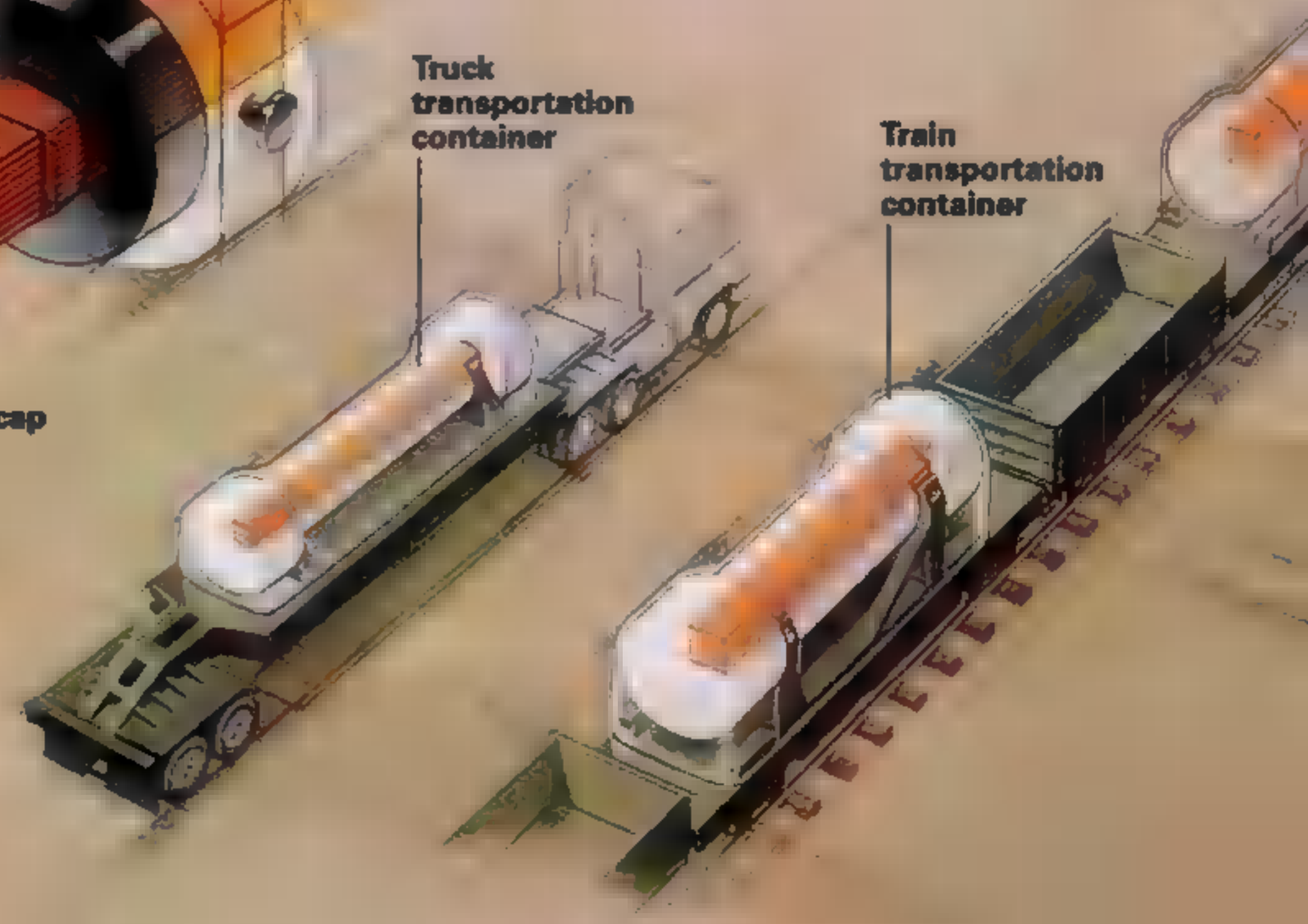
1 The Core of the Problem

In a nuclear reactor, enriched uranium pellets fill metal fuel rods that are grouped into fuel assemblies. The fission of uranium generates heat. Once the fuel is spent, the radioactive assembly must be cooled in water. It is then put in a container for transport to storage (below).



2 Safe Passage

During shipment, dumbbell-like cushions of balsa wood and other materials protect a transportation container. Along the rails, buffer cars fore and aft shield a train shipment. At Yucca the waste will be transferred to permanent disposal containers.



Nuclear Waste Storage Site

COMMERCIAL REACTOR
- Operating
- Shut down

RESEARCH REACTOR
- Operating
- Shut down

OTHER
- Department of Energy spent nuclear fuel and high-level waste
- Surplus plutonium
- Naval reactor fuel
- Spent nuclear fuel not at reactor
- Commercial high-level waste

ME.
MASS.
CONN.
R.I.
VT.
N.H.
N.Y.
N.J.
DEL.
MD.
Washington, D.C.
PA.
THREE MILE ISLAND
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W. VA.
VA.
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SAVANNAH RIVER SITE
GA.
ALA.
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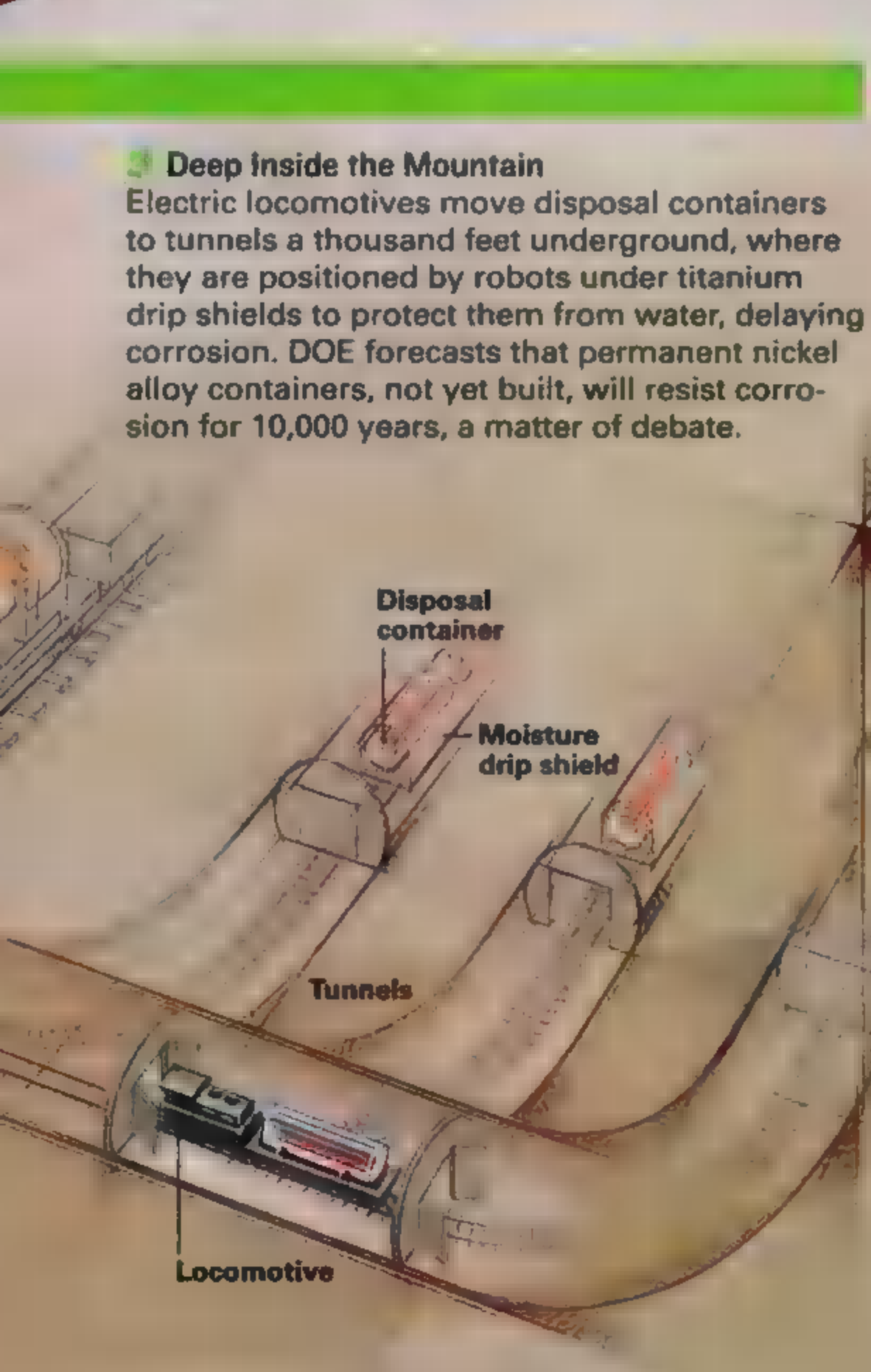
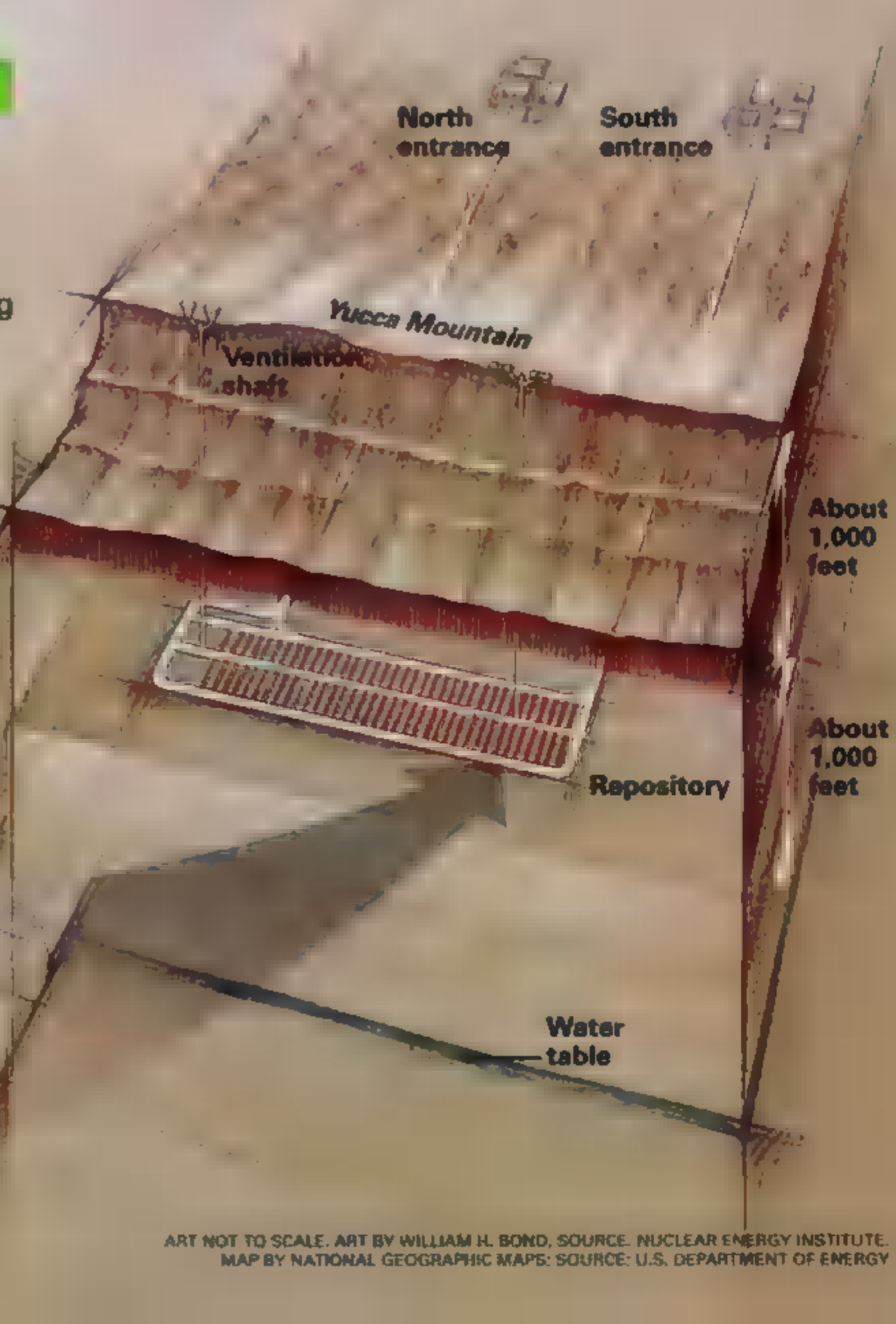
MINN.
WIS.
MICH.
ILL.
IND.
KY.
TENN.
PRAIRIE ISLAND
Minneapolis
Chicago
ARGONNE NATIONAL LABORATORY
GASEOUS DIFFUSION PLANT
Paducah
OAK RIDGE NATIONAL LABORATORY
LOS ALAMOS NATIONAL LABORATORY
Santa Fe
SANDIA NATIONAL LABORATORIES
Albuquerque
Carlsbad
WASTE ISOLATION PILOT PLANT
(Existing repository)
NEW MEXICO
Alamogordo

Deep Inside the Mountain

Electric locomotives move disposal containers to tunnels a thousand feet underground, where they are positioned by robots under titanium drip shields to protect them from water, delaying corrosion. DOE forecasts that permanent nickel alloy containers, not yet built, will resist corrosion for 10,000 years, a matter of debate.





ART NOT TO SCALE. ART BY WILLIAM H. BOND, SOURCE: NUCLEAR ENERGY INSTITUTE.
MAP BY NATIONAL GEOGRAPHIC MAPS; SOURCE: U.S. DEPARTMENT OF ENERGY

TYPES OF WASTE

When is radioactive waste safe? Some say it's safe now, if it's contained. Some say it's safe after ten half-lives—a half-life being the time it takes for half an element's atoms to decay. (For plutonium 239 the half-life is 24,000 years.) Paradoxically, the shorter the half-life, the more intense the radiation. The lethal punch of radiation depends on such obscurities as rem, curies, alpha particles, and the like. Each of the following types of waste, listed from most to least radioactive, could pose a risk for more than a million years.

HIGH-LEVEL WASTE

The most dangerously radioactive waste comes from two chief sources: Spent fuel from nuclear reactors (52,000 tons) and liquid and solid waste from plutonium production (91 million gallons).

TRANSURANIC

Transuranic waste includes clothing, tools, and other materials contaminated with plutonium, neptunium, and other man-made elements heavier than uranium, hence, transuranic. About 11.3 million cubic feet of this waste lies buried at government sites, and some has been deposited in salt caverns in New Mexico.

LOW AND MIXED LOW-LEVEL

This catchall includes radioactive and hazardous wastes from hospitals and research institutions, including remnants of decommissioned power plants, air filters, clothing, and tools. Total: Some 472 million cubic feet.

URANIUM MILL TAILINGS

These are residues left from the extraction of uranium from ore. At 265 million tons, this is the largest volume of waste but has the lowest radioactivity.

Mazurowski, DOE manager at Rocky, who supervises a cleanup crew of some 5,000 people at a cost of two million dollars a day. Mazurowski confronts me in a stance so sturdy she seems sprouted from Rocky Mountain granite. As she speaks, her hands fly in formation like two jet fighters, veering as she makes her point: "We sullied this environment, and now we're cleaning it up. A site of this magnitude has never been closed. When we're finished in 2006, all you will see here is grass."

Looking at Rocky's 400 acres of buildings and roads, I find this hard to believe. But here and there lie heaps of concrete rubble, remnants of buildings already dismantled.

Mazurowski takes me on a tour of Building 771, a former plutonium fabrication center once described as the "most dangerous building in the U.S." and still a radiation threat despite partial cleanup. We stretch into protective rubber clothing from booties to gloves to bonnets. Only our faces are exposed, because there's little chance of airborne contamination.

We pass scores of glove boxes, whose rubber gloves—mixed with lead to shield technicians from radiation—hang as if still waiting for someone to insert hands, reach inside the steel boxes, and manipulate plutonium into a shape appropriate for a thermonuclear explosion.

Workers use torches to cut the boxes, unused since 1989, into chunks to be placed in drums for transport to the Waste Isolation Pilot Plant near Carlsbad, New Mexico, to be buried permanently in 2,150-foot-deep caverns hacked out of ancient salt.

The room is humid and dark, and the torches spit out luminescent sparks. I wipe my bare forehead with my rubber-gloved hand, forgetting I have been forbidden to do so because my glove might have picked up an errant speck of plutonium spewing radiation in the form of billions of alpha particles. This is a big deal. Though alpha can be stopped by a piece of paper, they are particularly dangerous if inhaled or swallowed. I own up. A technician waves a radiation counter close to my face to detect any alpha. Fortunately, I'm clean.

Above is a cat's cradle of miles of pipes, from which radioactive liquid is being drained. Bit by bit, pipe by pipe, glove box piece by piece, Building 771 is returning to grass.

I left Rocky that day fairly impressed with the professionalism and cleanup efforts of

Sealed head to toe, a technician at Savannah River Site, South Carolina, sprays water heated to 180° F to decontaminate a cask emptied of spent fuel. His dosimeter records exposure to radiation, and he is checked every time he leaves the plant. Harold Hargan (right) worked at a nuclear facility in Kentucky for nearly 40 years before retiring. "Plant officials never told me I was being routinely exposed to plutonium and other radioactive materials," says Hargan, who blames such exposure for his bladder cancer and loss of a kidney. He is a party to a class-action suit filed against former operators of the plant and has also applied for $150,000 under a federal law that remunerates nuclear workers if they have certain illnesses.

manager Mazurowski and her troops. Later, to get another viewpoint, I sought out Len Ackland, director of the Center for Environmental Journalism at the University of Colorado, Boulder, and author of a critical book about the plant, *Making a Real Killing*. I asked Ackland what he thinks of Rocky Flats going back to grass. He responded with a significant question: "What's beneath the grass?"

The answer: dirt specked with plutonium. Environmentalists would like the plutonium removed; DOE says the radiation will be minuscule, about one millirem a year, adding that it would cost millions to replace the soil.

ROCKY FLATS may be DOE's poster child for cleanup success, but a sister facility, the 586-square-mile Hanford Site, in Washington State, is quite another matter. Here reposes the country's greatest volume of high-level nuclear waste.

The Hanford inventory includes 53 million gallons of waste from plutonium processing stored in underground tanks, nearly 2,300 tons of spent fuel, four and a half tons of plutonium, 25 million cubic feet of solid waste, and 38 billion cubic feet of contaminated soil and groundwater. In a storage pool I look at the

PADUCAH, KY

Some 38,000 cylinders of depleted uranium, many in poor condition, lie outside the Paducah Gaseous Diffusion Plant, a center for nuclear-fuel processing. Tainted groundwater has forced the government to provide municipal water for nearby residents.

nation's most lethal single source of radiation excepting reactor cores—1,936 steel cylinders containing cesium and strontium covered by 13 feet of water. When a technician switches off the lights, radiation from the cylinders puts on a light show of royal blue.

Hanford reactors made plutonium for the first nuclear explosion, near Alamogordo, New Mexico, in 1945 and for the bomb dropped on Nagasaki (the Hiroshima bomb used uranium). Hanford had produced about 59 tons of bomb-grade plutonium by the time it closed in 1989.

From the earliest days, Hanford scientists observed that radionuclides—a catchall term for radioactive atoms—were entering the environment. Iodine 131, a gas by-product of plutonium processing, escaped from unfiltered stacks. Water taken from the nearby Columbia River to cool reactors was returned to the river with a burden of radioactive sodium, zinc, arsenic, even some -ium elements.

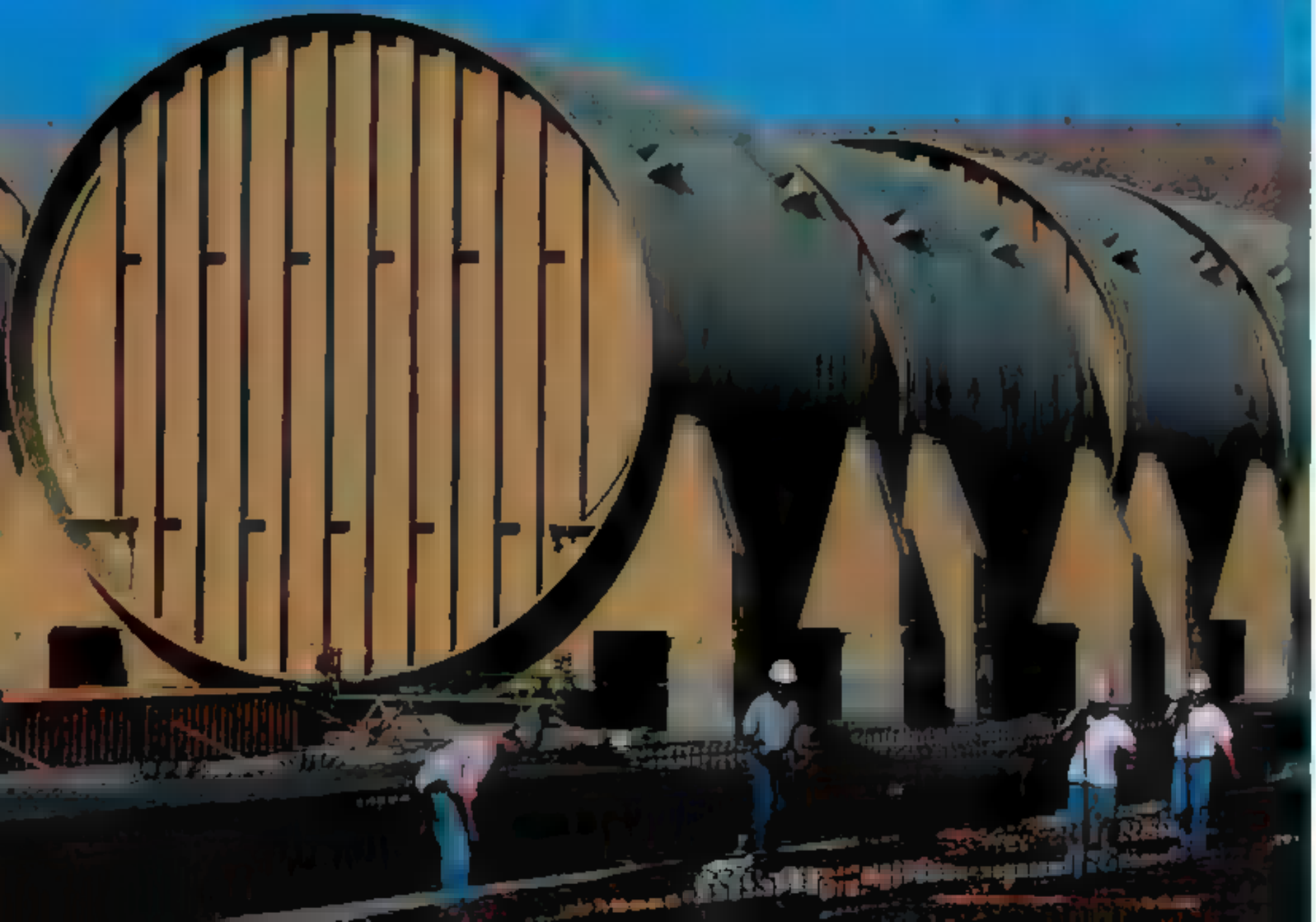
Later, waste stored in underground tanks leaked into the soil, and 45 billion gallons of contaminated liquids were dumped onsite, some near leaking tanks. Thus contaminated plumes were created underground, some threatening the Columbia. The press began reporting claims of increasing rates of cancer in people and birth defects in people and animals in farm areas near Hanford.

In September 1985 Michael Lawrence, DOE manager of the site, met the farmers to consider their concerns. That radiation causes illness in an individual is virtually impossible to prove; nonetheless Lawrence decided to release previously classified information, beginning with 19,000 pages of documents written by Hanford scientists as far back as 1943. Lawrence was the first DOE official to do such a thing, and his decision "raised some eyebrows," he remembers, back in Washington, D.C.

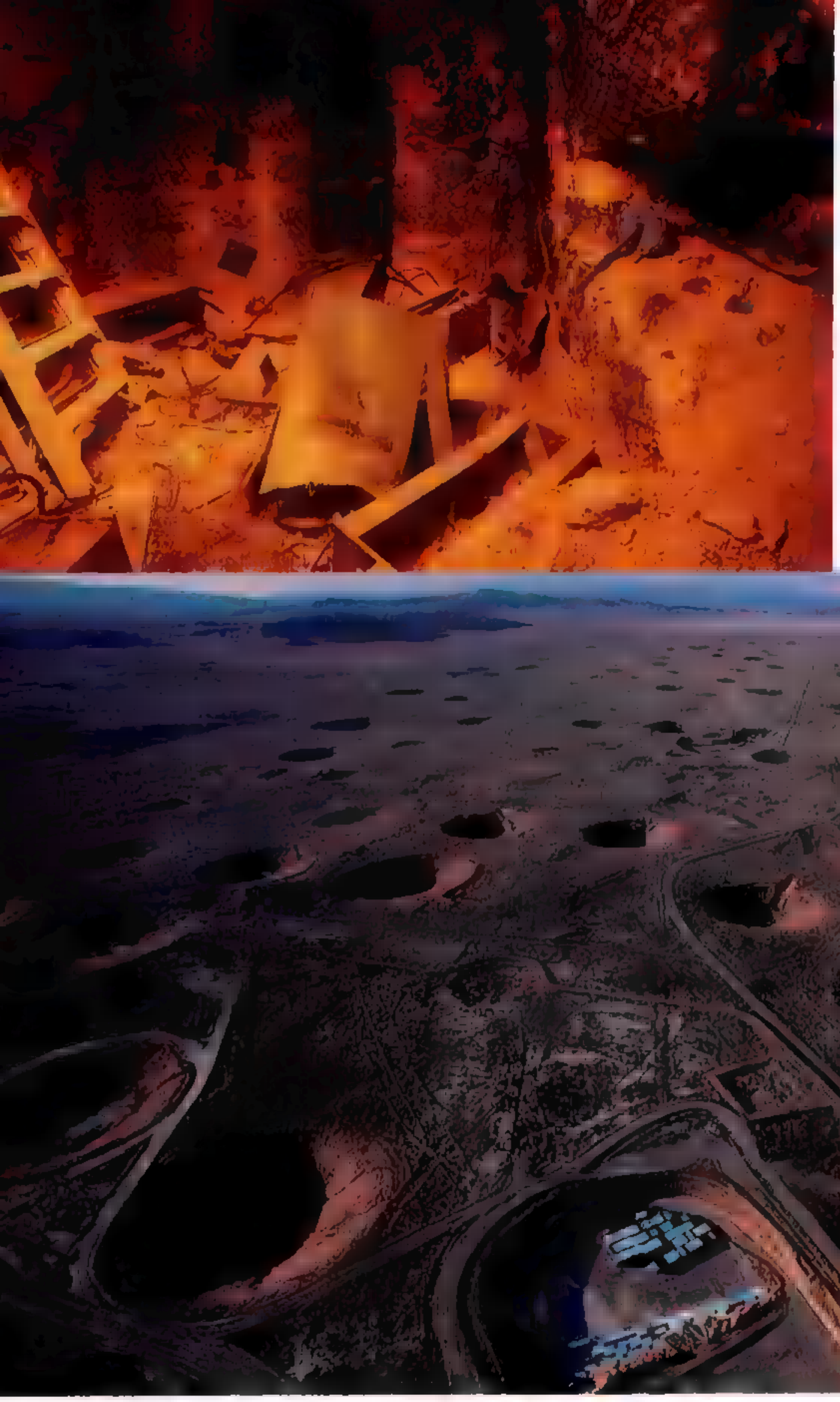
In Hanford other eyebrows were raising, especially those of Michele Gerber, a housewife, mother, and trained historian who was poring over the released documents. "The scientists didn't believe the texts would be read in their lifetime," Gerber told me. "I was dumbfounded at how shockingly candid they were."

During early releases of iodine 131 in the 1940s, technicians nonchalantly recorded that the radioactive gas was spreading farther than anticipated. "They just enlarged their sampling circles," Gerber said, "to 25, 50, 100, 150 miles, all the way to Spokane and Walla Walla."

Rusting drums of waste at Los Alamos National Laboratory in New Mexico recall past haphazard disposal. A lab spokesman questioned whether this photo was taken at Los Alamos, saying, "we do not store drums in a configuration like that." Later he said that this arrangement represents "strict compliance with all radioactive waste disposal regulations."



Shielded by radiation-proof glass at Rocky Flats (facing page), a worker with a torch dismantles steel boxes used in making plutonium triggers for bombs. Buckets and other containers for radioactive materials (above) await disposal at Oak Ridge National Laboratory in Tennessee. Sealed hull sections of 92 submarines containing nuclear propulsion reactors emptied of fuel rest at Hanford (left).



One of many craters from nuclear weapons testing serves as a grave (below) for low-level waste at the Nevada Test Site. Until 1992 the U.S. conducted more than 800 underground explosions here. Technicians now simulate testing with computers. To acquire real-world data for computers, a conventional explosion was set off below ground (left).

Trancelike, Gerber read through the night till sunup. "I was thinking—you *did what?* Why didn't you stop? Why didn't you change the production process to reduce the emissions?"

Many doubted the data until contamination was found in desert flowers decorating the desk of an official. Concern mounted, but Hanford had plutonium production quotas to meet. Special silver filters finally stopped 99 percent of iodine emissions by 1952.

Gerber's book detailing pollution at Hanford, *On the Home Front,* was published in 1992, a work of history dispassionately told, thoroughly footnoted, the literary equivalent of a nuclear explosion. The fallout: Though Hanford scientists knew they were contaminating the environment, they didn't tell the public about it.

The public felt betrayed. Roy Gephart, a geohydrologist who had been involved with Hanford for 28 years, said Gerber's book taught him "things I never knew. I talked to workers who said they were taken by surprise when they read the book. They felt deceived. That's why many Americans distrust us today."

Gephart is now a program manager in environmental sciences at Pacific Northwest National Laboratory, a federal facility near

Hanford. "The important thing is to do the cleanup right and regain the public trust," he says, "but that may take another generation."

They're building a four-billion-dollar plant now at Hanford to vitrify radioactive waste in glass for storage, burying low-level waste in giant pits lined with impervious plastic, finding cesium in the dirt of reactor storage pools, roofing old reactors in steel for a 75-year wait until radioactivity diminishes, and installing hundreds of wells to monitor underground plumes. "If the plumes ever threaten human health," says Gephart, "we plan to intercept them, build barriers, and stabilize the contaminants. However, most plumes will remain untouched because of cost, risk, and the lack of suitable technology."

Michele Gerber looks back: "The Cold War really was a war," she says. "And Hanford was a battlefield with a different kind of destruction, radionuclides pervading the environment. You can't have the production that Hanford did and not have the waste. I'm optimistic we'll clean it up. All I ever wanted was a clean river."

Another Cold War battlefield, the Idaho National Engineering and Environmental Laboratory (INEEL), west of Idaho Falls, began its career as a firing range for battleship guns in World War II. Later this vast expanse of sagebrush and shrub became a research center for nuclear reactors and for a time was used as a permanent repository for some nuclear waste.

INEEL received thousands of barrels of waste by train from Rocky Flats until October 1988, when Idaho Governor Cecil Andrus ordered state troopers to block the shipment. The train motored back to Colorado, among its freight cars a maroon one numbered 6503 that you can still see on a siding at Rocky—the waste long ago removed, of course.

YUCCA MOUNTAIN: LONG-TERM THREAT?

THE RADIOACTIVITY of waste rapidly during the first 300 years Yucca as short-lived cesium and strontium decay. The continues with plutonium and other long-lived elements for a million years. computer simulations predict that nickel containers won't corrode and release radioactivity at least 10,000 years, the EPA's required isolation period. opponents contend that may sooner, but one knows for certain. Definitive tests on containers have not been

HOW MUCH RADIATION will people near Yucca receive? When containers radioactive elements migrate through rock fractures to contaminate groundwater—and affect people who use it. computer models predict a maximum annual radiation dose after 400,000 years that is twice the area's level of naturally occurring radiation and far above the EPA's millirem standard for Radiation dose estimates from scientists diverge widely, above and below DOE figures, reflecting an unresolved controversy.

GRAPHS ADAPTED FROM ENVIRONMENTAL IMPACT STATEMENT, U.S. DEPARTMENT OF ENERGY; BY JOHN R. ANDERSON, JR., ART

Shipments soon resumed, however. In 1995 INEEL decided to burn the plutonium-contaminated waste in a state-of-the-art incinerator. As explained to me, the machine would separate the plutonium while burning PCBs and other chemicals. An infinitesimal fraction of plutonium might escape, INEEL experts said, but not enough to be harmful.

A hundred miles away in Jackson, Wyoming, a cowboy-chic redoubt of the wealthy as well as a way point for tourists bound for Yellowstone, folks did not see it that way. They worried about "a cloud of plutonium particles blowing in our direction," said Angus Thuermer, Jr.,

editor of the *Jackson Hole News*. "Alarm bells were ringing from one end of the valley to the other. INEEL said it was safe, but a lot of people here don't trust the government."

One was Gerry Spence, a famed trial lawyer who frequently appears on TV talk shows wearing a deerskin shirt. "INEEL acted as if these nuclear particles would drop the minute they hit the Wyoming border," he said. At a meeting of a thousand Jacksonians in 1999, Spence laid out the plutonium threat. "It was a closing argument before the jury," he remembered, "and the people prevailed." Harrison Ford pledged $50,000 to the cause. Others joined, and in a half hour Spence had raised $500,000. An organization was launched, Keep Yellowstone Nuclear Free.

In an editorial, *Powder*, a skiing magazine, speculated that Jackson skiers would schuss on "nuclear powder" during a "nuclear winter," leaving headlamps at home, presumably because the night would be lighted by the glow of nuclear material.

Plutonium doesn't glow in the dark, however, and some Jackson citizens were mighty skeptical that plutonium cinders would smudge their town. "There's no evidence, zip, that plutonium or any other radioactive material will descend upon Jackson," said Jerry Fussell, a former professor of nuclear engineering at the

Rolling south through New Mexico on Interstate 25, a truck carries two containers—each holding 14 drums—of transuranic waste from Rocky Flats. The load is headed for entombment in a salt cavern (right) at the Waste Isolation Pilot Plant near Carlsbad. At WIPP an elevator takes the drums 2,150 feet underground. Over time, the salt in this deposit will flow over the drums and encase them.

University of Tennessee specializing in nuclear systems risk assessment. "Can you imagine a whirlwind in Idaho Falls winding up and pitching nuclear materials to Jackson Hole? Ridiculous." Fussell, who has served as a U.S. delegate to the International Atomic Energy Agency for discussions of radioactive releases, said, "It will be a disgrace if Jackson prevents operation of that incinerator."

Prevented it was. Gerry Spence sued, and after a year of wrangling, an agreement was struck: INEEL would investigate alternatives to incineration of the plutonium-contaminated waste, which remains on site. Spence agreed not to bring suit questioning the disposition of other waste. One INEEL official told me, "It's not the most pleasant thing, having Gerry Spence on your tail."

I repeated the remark to Spence, and he

TRUCKS CARRY TRANSURANIC WASTE OVER INTERSTATE HIGHWAYS TO A BURIAL SITE IN NEW MEXICO, WHICH WILL BE FILLED WITH AN ESTIMATED 850,000 DRUMS BY 2035.

smiled. We were sitting on the back porch of his ranch north of Dubois, Wyoming, where Spence looks taller and younger—he was 71—than on TV. A chirping gallery of robins and warblers failed to interrupt his gloomy assessment of nuclear waste storage.

"The idea that we could find some safe way to deal with that waste is simply a myth," Spence said. "First you have to haul it. Am I to believe that there will never be any acts of God that will intervene? That's what they said about the *Titanic*."

Other people on the nuclear waste trail spoke with equal candor—a scientist, an activist, a DOE manager, an environmentalist, and a river guide.

ARJUN MAKHIJANI Smart, informed, thoughtful, this India-born Ph.D. in electrical engineering has critiqued the nuclear scene for 20 years. The most dramatic sideburns I have ever seen hang from his temples like onions—white, bulbous, huge. With eight staffers he runs the Institute for Energy and Environmental Research, a think tank in Takoma Park, Maryland, a suburb of Washington, D.C. Makhijani told me he'd rather do something else, but DOE keeps him busy.

"I am a constructive critic," he says. As an

HANFORD, WA

Circles mark the spots of four double-walled underground tanks that hold radioactive waste from plutonium processing — Hanford's specialty from 1943 to 1989. In all, 177 tanks hold 53 million gallons destined for vitrification in glass. With this muck and other lethal garbage, Hanford houses the nation's largest concentration of high-level nuclear wastes.

example he offers his detective work on the amount of transuranic waste haphazardly buried in the 1950s and '60s, when trucks simply dumped barrels of plutonium-contaminated waste into pits and trenches. A layer of soil was spread over the waste, then heavy equipment leveled it. The process was repeated.

Trying to gauge the amount of waste in the pits, Makhijani studied government records and concluded that officials were guessing: "They were throwing darts." He sent a critique to DOE, which looked it over for two years and finally agreed with him, admitting there was

ten times more radioactivity in plutonium-contaminated waste buried in pits throughout the nuclear weapons establishment than they thought. "There is a ton of plutonium in Idaho alone," says Makhijani. "Some of it is leaching through the soil and threatening the Snake River aquifer."

Makhijani favors the phaseout of nuclear power, replacing it with wind power. "In 12 Midwest states there's enough wind potential to generate three times the U.S. production of electricity," he says.

MARCUS PAGE In Las Vegas, I met this antinuclear, peace activist who was once arrested for protesting Star Wars at Vandenberg Air Force Base in California. He regularly shows up at antinuclear protests, where he unpacks a portable radio station and starts broadcasting for Catholic Worker Kommunity Radio. At our meeting he wore a dimpled, narrow-brimmed, round-topped, black felt hat that seemed a bit too small, exactly the kind of hat, I imagined, that Rumpelstiltskin himself would have worn. I admired it. Page immediately took it off and gave it to me.

Page wants to abolish nuclear weapons and power plants because "they just create more waste. There is no safe way to store it, so it is irresponsible to generate radioactive materials that last for hundreds of generations."

INÉS TRIAY Another of DOE's talented young managers, Triay escaped from Cuba at the age of three with her parents and later earned a Ph.D. in chemistry from the University of Miami. She manages the Waste Isolation Pilot Plant in New Mexico, a repository that expects to receive 850,000 drums of transuranic waste by 2035. "I intend to reduce that by at least 15 years," says Triay, who runs the plant "like a business," despite a plethora of regulations. "There are literally tens of thousands of

At Hanford all is being demolished but the tall central structure that contains D reactor, one of nine that made plutonium. D reactor won't be torn down until 2077, when radioactivity has diminished. The shell of ■ school (facing page) is nearly all that remains of Hanford town. Its 300 citizens were relocated in 1943, when construction of the site began.

Wearing lead-impregnated gloves to protect against radiation, ■ Hanford technician secures a lid on a drum of low-level waste (above). The compactor at rear crushes these drums so more can be held in storage. A tank farm at Hanford (left), built in the 1940s, used only single-wall tanks to store radioactive sludge from plutonium processing. Many of the tanks leaked, tainting groundwater.

requirements I have to meet," she says. "Many duplicate and waste time and money." If she succeeds, she will achieve a cost underrun of around eight billion dollars off the original 16-billion-dollar figure.

JONI ARENDS She's the waste programs director for Concerned Citizens for Nuclear Safety, an environmental group in Santa Fe, New Mexico. Late one afternoon at a Tex-Mex restaurant on Cerrillos Road, we sat at the bar, and I listened as Arends recited a list of government environmental mischief, from alpha particles to omegaton anxieties. After three Dr Peppers I asked, "Joni, is there anything the United States government has done in the past 50 years that you approve of?"

She looked away thoughtfully, and after a time looked back. "Yes," she said, "President Eisenhower built the Interstate Highway System."

DAVID LYLE A river guide, Lyle feels happy when running rapids and "lousy" when looking at a humongous mound of uranium tailings close by the Colorado River near his home in Moab, Utah. Because ammonia leaches from the tailings into the river to threaten endangered fish, because cancer-causing radon wafting from the pile has settled as a radon "fog," and because he's just tired of looking at ten million tons of tailings.

"The citizens of Moab have yelled about this for 25 years," protests Lyle.

The Moab pile is an ugly duckling amid the glorious desert scenery of Arches National Park and the Scott M. Matheson wetlands nearby. DOE is pondering whether to move it—at a cost of 364 million dollars—or to attempt to contain the leaking ammonia and other groundwater pollution.

For Spence, Makhijani, Arends, and many others, the safety of nuclear materials shipped by highway and rail is a prime concern. Near Chugwater, Wyoming, I encountered such a shipment when returning to my home in Denver from a fishing trip. A clutch of military humvees with troops, big Chevy Suburbans wearing "Security Forces" signs, and a circling helicopter rode shotgun around a large white trailer bearing a U.S. Air Force logo—all creeping along at 50 miles an hour on an interstate that allowed 75. On the door of the lead vehicle another sign declared, "The United States of America."

How to find out whether this was nuclear waste or just something nuclear?

I decided to create a nuisance, pulling past the convoy and parking by the roadside, holding my cell phone suspiciously, I hoped, with my laptop open. The third time I parked, it was dark. I had given up attracting attention.

Suddenly my door was cracked open by a fit, squarely built man in a blue jumpsuit with cartridge belt who identified himself as a U.S. marshal. "We're wondering why you're doing this," he said. He had sneaked up behind me with his lights off and now shielded his right hand, cupping his sidearm I supposed. The helicopter hovered, its spotlight in my face.

I sputtered that I was a NATIONAL GEOGRAPHIC writer working on a story on nuclear waste. "We know who you are," he replied. Just then the convoy with the trailer passed.

"Is that nuclear waste?" I asked.

"No," he replied.

"Can you tell me what it is?"

"No."

Marshal Douglas Lineen closed my door and departed, and so did the helicopter, leaving me resolved to stop annoying these people and to try to find out if the suspect cargo might be a nuclear warhead.

"With all that security, probably a complete weapon," said Douglas Ammerman, an engineer at Sandia National Laboratories in Albuquerque, New Mexico, when I asked him later. Ammerman makes a living banging up one-quarter- to one-half-scale steel

I SPUTTERED THAT I WAS A NATIONAL GEOGRAPHIC WRITER WORKING ON A STORY ON NUCLEAR WASTE. "WE KNOW WHO YOU ARE," THE U.S. MARSHAL REPLIED.

A steel capsule holds one [illegible] of rare californium 252 created in a nuclear reactor at Oak [illegible]. The element, which does not exist in nature, costs $68,000 a milligram [illegible] 68 million dollars a pound. Californium is used in a process similar to [illegible], enabling technicians to see inside waste [illegible] and itemize their radioactive contents.

An [illegible] manipulates robotic [illegible] at [illegible] River [illegible] take the [illegible] of a [illegible] containing two tons of waste [illegible] mixed [illegible] molten [illegible] [illegible] for safer [illegible]. Like oil in water, nonradioactive [illegible] rises to the top of a beaker in an [illegible] Ridge simulation of how to [illegible] highly radioactive cesium from less lethal waste.

The puffless cooling towers of a reactor at Three Mile Island recall its partial meltdown and closure in 1979. Despite a national uproar over the accident near Harrisburg, Pennsylvania, radioactivity release was minimal. A second reactor there continues to operate. Fuel from the damaged reactor is stored in casks at an Idaho facility (left).

containers designed to carry nuclear waste.

His technicians drop, burn, immerse, try to puncture, and otherwise torture such containers to test their integrity. In one spectacular instance, they rammed a locomotive at 81 miles an hour into an obsolete, full-size cask mounted on a flatbed, damaging the locomotive but not the cask.

Ammerman told me he couldn't think of a situation that might rupture a cask. "Perhaps if you were going past Mount St. Helens when it blew," he offered.

Don Hancock, the nuclear waste program director for the Southwest Research and Information Center in Albuquerque, challenged Ammerman's statement. Hancock noted that a freight train carrying hazardous waste wrecked last year in a tunnel in Baltimore, causing a fire that burned for five days. "They had to close the tunnel. Suppose that had been a spent fuel shipment?" he asked.

Hancock observed that a propane fire burns at 2,000 degrees F. The Nuclear Regulatory Commission specifies that casks be tested by burning them in fuel for a half hour at a temperature of 1,475 degrees F.

At the offices of the NRC in Rockville, Maryland, I put the question to E. William Brach, director of the Spent Fuel Project Office. Why 1,475 degrees? Brach looked at me, then turned a quizzical expression toward Mark Delligatti, senior project manager, who shrugged.

It turns out the NRC adopted the standard in 1965, taking it and other canons from International Atomic Energy Agency requirements published in 1961. Hancock regards these 40-year-old standards as obsolete.

"I would like to see full-size containers tested to failure," he says, "as automobiles are. We need to know what kind of crash or fire will rupture a cask."

An important consideration, it would seem, because shipments of high-level waste on the nation's highways and railroads could eventually deliver tens of thousands of tons of spent fuel, from nuclear power plants and Navy ships, and other dangerous waste to a repository. Spent fuel from power plants alone increases at the rate of 2,000 tons a year. Already some plant water-storage pools are filled, and the overflow spent fuel is stored above ground in casks that can be licensed as safe for at least 20 years. Some say store the stuff above ground and maybe new technology will come along and solve the problem.

If the government has its way, shipments will head for Yucca Mountain, 90 miles northwest of Las Vegas, chosen by Congress in 1987 as a potential resting place for the nation's spent fuel rods and other high-level waste. DOE has invested four billion dollars testing and tunneling Yucca amid controversy as thick as the compacted volcanic ash that comprises the 1,500-foot-high ridge.

Adamantly, the state of Nevada finds "significant and unacceptable risks" just about

IS NEVADA'S YUCCA MOUNTAIN THE BEST SITE FOR PERMANENT BURIAL OF HIGH-LEVEL WASTE? THE FEDS SAY YES. STATE OFFICIALS AND ENVIRONMENTALISTS SAY NO.

everywhere it looks in Yucca Mountain, from geology to groundwater to nickel alloy containers (for the spent fuel) that DOE says will last at least 10,000 years. More like 500, says Nevada, and many environmentalists agree.

In January, Spencer Abraham, Secretary of Energy, declared the site "scientifically sound" and "technically suitable" for development, forwarding the matter to the President as the law requires, while firing a shot across the bow of battleship Nevada.

Nevada fired back. Senator John Ensign retorted, "The Department of Energy has been hell-bent on building Yucca Mountain no

Yucca Mountain's south entrance gapes as if ready to devour the nation's waste. Yet a watchdog group of presidentially appointed scientists says Yucca's approval as a repository was based on science that is "weak to moderate," and licensing remains years away. Maintaining that all will be well, DOE plans to fill the repository gradually, over decades. But with high-level nuclear waste piling up by more than 2,000 tons a year, the site will be nearly full from the start—and the nation will be looking for Yucca II in the near future.

matter what the science, what the ethics, what the cost." Governor Kenny Quinn threatened to bring suit all the way to the Supreme Court.

After President Bush approved the site on February 15, Nevada filed a notice of disapproval on April 8, sending the matter to Congress, which can override Nevada's veto by a majority vote. Pending state lawsuits and approval of DOE's license application to the NRC, DOE will proceed to build the site, which could be in operation as early as 2010.

The Environmental Protection Agency has ruled that DOE must demonstrate that Yucca Mountain can meet EPA standards for public and environmental health for 10,000 years. Does that mean radioactivity won't be a threat after 10,000 years? Nope. The peak radiation dose to the environment will occur after 400,000 years, according to DOE.

Nevertheless, and despite objections from many scientists, EPA decided on 10,000 years because of "tremendous uncertainties" beyond that period.

"Do you think we will still have a Department of Energy 300,000 years from now?" I was asked by Steve Page, director of EPA's Office of Radiation and Indoor Air.

I don't know. But there's no uncertainty about how long it takes radioactivity to subside, about ten half-lives. For plutonium 239, this is 240,000 years.

There are no textbook solutions. Some environmentalists would settle for a compliance period of 250,000 to 500,000 years. The Swedes are shooting for a lot longer. To store their high-level waste, they plan to use steel containers coated with copper, which won't corrode in the absence of oxygen, imbedded 1,800 feet in granite (an option rejected in the U.S.) and surrounded by impervious clay to inhibit moisture transport. They expect this architecture to contain radioactivity for a million years.

That's plenty of time for *Homo sapiens* to experience evolutionary changes. Perhaps to a species we might call *Homo furioso*, wondering loudly—what were those ancient Americans thinking when they put that hot stuff in the earth and decided 10,000 years was time enough to contain it?

MORE ON [redacted] WEBSITE

What are your concerns about the containment of nuclear waste? Share your thoughts on our forum board at **nationalgeographic.com/ngm/0207**.

THERE MAY BE a better way, according to Yoon Chang, associate director of Argonne National Laboratory near Chicago and an expert in reactor technology. Today's inefficient reactors burn only 3 percent of the fuel. The other 97 percent is declared "spent," fit only for Yucca Mountain.

In an ambitious recycling project, Chang wants to use that fuel in an advanced "fast" reactor that, on paper, promises to burn 99.9 percent of the fuel, including all but 0.1 percent of the plutonium and its -ium friends requiring long-term storage. "Most of the waste will be an ashlike residue of fission products that will be harmless"—now hear this—"in only 300 years," Chang predicts, though some disagree.

Not even Homer Simpson could melt down a fast reactor, says Chang. Its sodium coolant has a high boiling point—today's reactors use water—and would absorb excess heat. Meanwhile, the fuel elements would expand and separate, stopping the chain reaction "without human intervention." Basic fast-reactor technology has been demonstrated, says Chang, and the next step is to get it working smoothly in one advanced design, an enormous project that would take "around ten years and two billion dollars in federal funds."

Fast reactor sounds too good to be true, and may be. Skeptics question whether its promise can be realized, noting, for example, that sodium catches fire easily. But Chang is optimistic.

Would you like to make a two-billion-dollar bet to settle this? Or would you rather build a Yucca Mountain every 50 years or so and make *Homo furioso* really mad? Perhaps you want to chuck everything nuclear and put your money on power from wind or solar sources.

These are questions the country will have to face, along with garbage problems still unsolved. One that haunts me concerns five plutonium-processing plants at Hanford. Three of these dingy gray hulks sprawl about a thousand feet long with walls of reinforced concrete up to eight feet thick. Tear these monsters down, and where do you put that rubble?

Some people are suggesting, don't tear 'em down. Fill 'em up with low-level waste and cover everything with the good earth. I like that, a harmonious conclusion to a contentious chapter in the nation's history—radioactivity returned to the womb that bore it. □

bald eagles come back from the brink

An enduring hallmark of wilderness greets the Alaska dawn. Mostly secure in their longtime strongholds of Alaska and Canada, bald eagles are now on the rise in the lower 48 states.

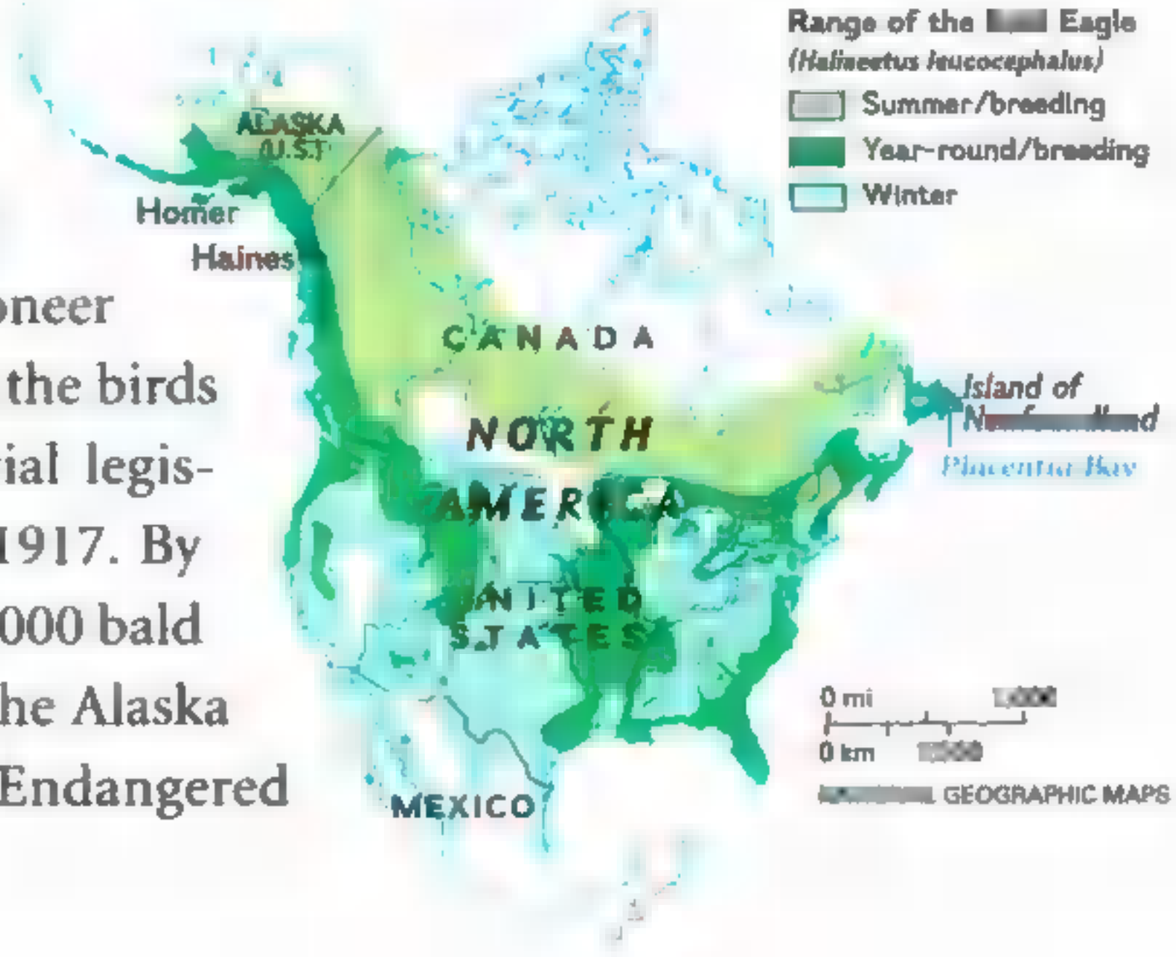
A somber convention of eagles gathers behind a breakwater in Homer, Alaska, on [illegible] winter day. "I counted more than 120," says photographer Norbert Rosing. Often solitary, the birds can become gregarious—especially when seeking shelter or food.

Eagle-eyed scavengers in Homer scuffle for a perch while awaiting handouts from benefactor Jean Keene. For 23 years she has fed fish to the eagles in winter, supplying up to 80,000 pounds because "it gives them a helping hand when food is scarce."

BY JOHN L. ELIOT • PHOTOGRAPHS BY NORBERT ROSING
NATIONAL GEOGRAPHIC

They ruled the skies on seven-foot wingspans when 17th-century Europeans arrived in North America. Throughout the continent, half a million bald eagles may have soared. But settlers blamed them for killing livestock, so shooting began—and the proud birds' numbers began to plunge.

In their northern range eagles remained relatively protected by isolation. But early last century, during Alaska's go-for-broke pioneer days, fishermen and fox farmers alleged that the birds were stealing their livelihood. The territorial legislature responded by enacting a bounty in 1917. By the time it was repealed in 1953, at least 128,000 bald eagles had been killed. It took 20 years for the Alaska birds to rebound. By 1973—the year the Endangered



Soaring on afternoon thermals, bald eagles wing from Homer past Alaska's Kenai Mountains. Ruffled by wind, one eagle pauses near Homer Spit, presenting a craggy—and classic—portrait (below).

Species Act was passed—populations in Alaska and much of Canada were stable, so bald eagles were not protected by the act in Alaska or by federal law in Canada. Today some 100,000 thrive in those two locations.

In the lower 48 states the birds fared much worse. The Bald Eagle Protection Act of 1940 prohibited shooting or otherwise harming the birds in the U.S. but didn't cover the pesticides that within a decade began to destroy eagles' eggs. By the 1960s only about 400 breeding pairs of bald eagles remained in the lower 48. "The trend . . . may well make it necessary for us to find a new national emblem," Rachel Carson warned in her 1962 masterwork, *Silent Spring*. The banning of DDT in 1972 and other measures launched an amazing comeback by the eagles, whose status changed from endangered to threatened in 1995. Today, with more than 6,000 breeding pairs, bald eagles may soon be taken off the endangered species list entirely, their survival as an icon secured—for now.

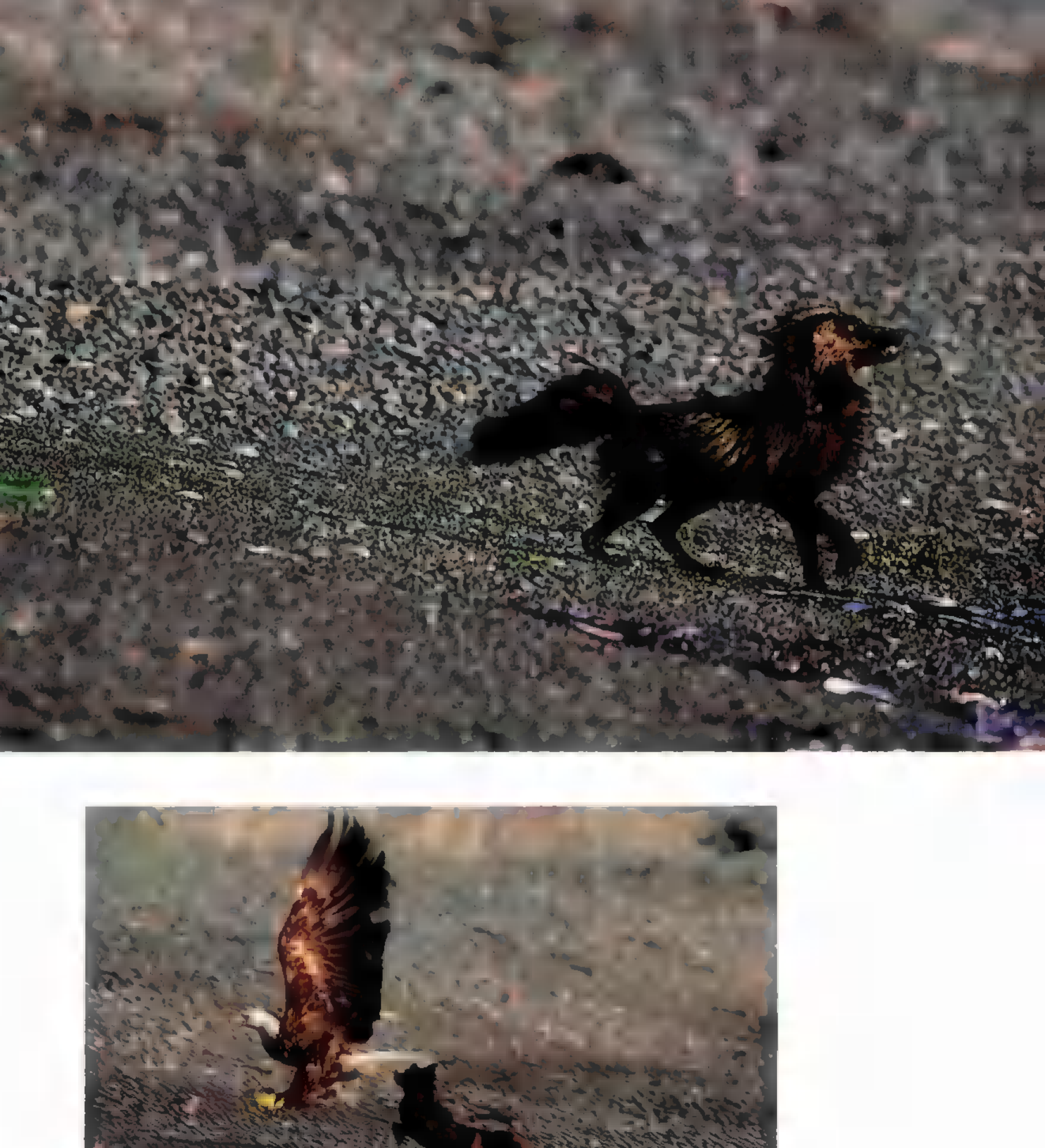
A bald eagle's nest
may reach ten feet across and
twenty feet deep.

From a blind near a cliff-top aerie, Rosing spent weeks photographing one eagle family in a nest near Placentia Bay on Newfoundland, home to 400 eagle pairs. Master anglers, eagles can spot a fish from high in the air then dive at up to a hundred miles an hour. Dangling its catch, an adult arrives at the nest (above). One eagle feeds the two hungry two-month-old eaglets (below), then takes off for another run (left). "The parents feed them three to five times a day," says Rosing. Soon these chicks will fledge and fly, though they will still roost near the nest for weeks.

"But you were never made, as I, / On the wings of the winds to fly! / The eagle said."

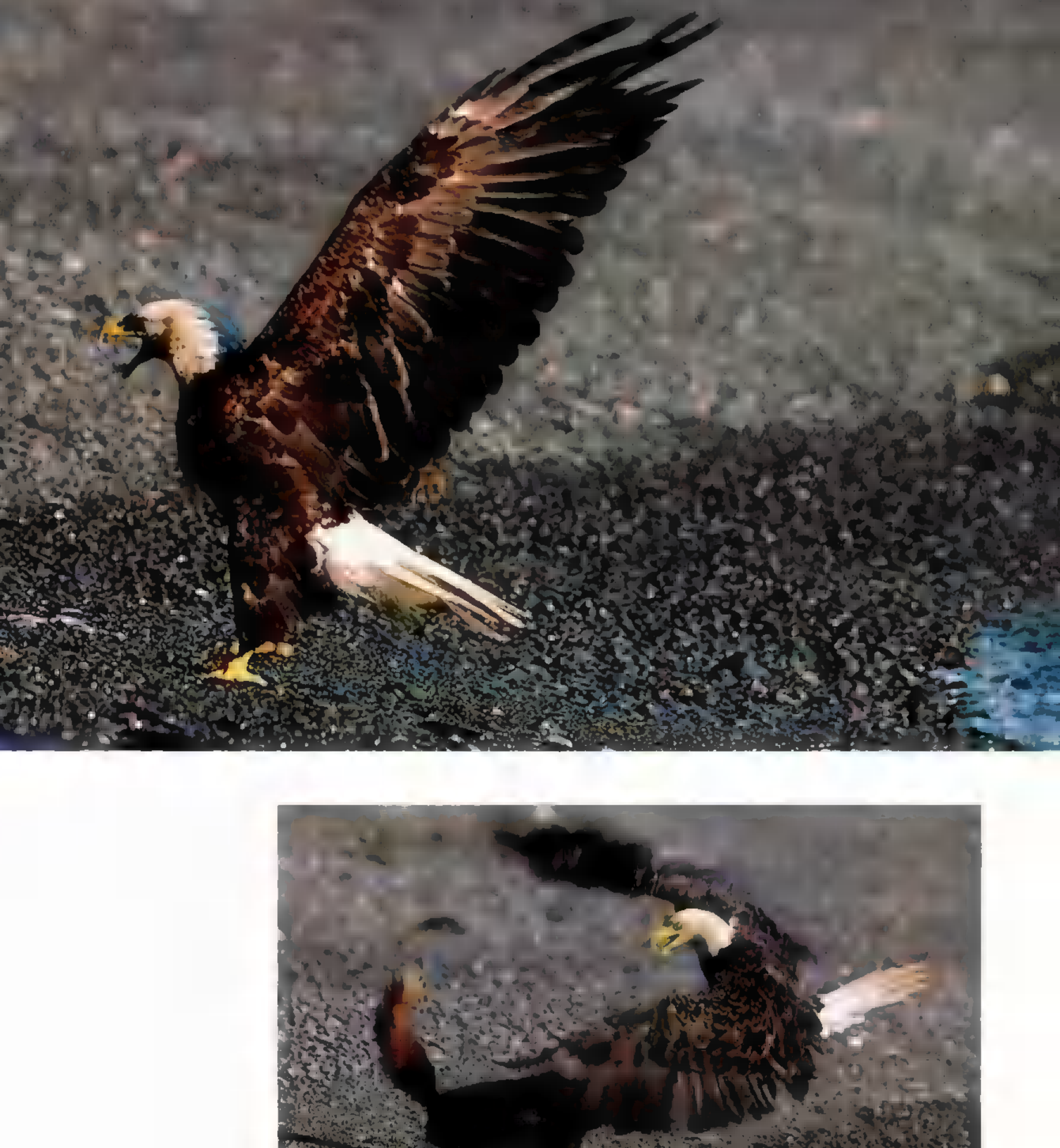
In 1911 poet Will Carleton captured the pride and grace of this supreme aerial predator.

The sea sets the table when millions of capelin swim ashore to spawn and die on Newfoundland's beaches in summer. Whales and seabirds comb the shallows for the silvery fish. Islanders with buckets collect their share. And eagles not only vie with each other (left) but occasionally have to deal with other crafty competitors.



A muddy red fox and a bald eagle square off on a capelin-strewn beach (below). "The eagle repeatedly flew off, then returned to claim the beach," Rosing says. For half an hour they traded threats, feints, and attacks. Sometimes the eagle leaped at the fox head-on (below right). Turning the tables, the fox charged the eagle, momentarily driving it off (below left). Eventually the capelin repast proved enough for both.

Spawning fish are windfalls for bald eagles. "One day 17 eagles were on this beach feeding on capelin," says Rosing. Though they often scavenge, the eagles will readily kill live fish and other prey, including birds and mammals.



A lone eagle greets
a frosted November
dawn on the Chilkat
River near Haines,
Alaska. A preserve
protects the last big
dried bald that
here year-round, but
thousands more
with fall to feed on
spawning salmon.

"Eagles just love to fight.
They'll even fight
eight fish at once."

It's snatch as snatch can when as many as 4,000 eagles pile up on a five-mile stretch of the Chilkat River. Here, in the fall, thousands of chum salmon spawn and die—and the eagles don't let them go to waste. In one aerobatic duel (left) the lower eagle defends a partly eaten salmon near the shore. Seconds later (above) the assailant dive-bombs the defender, spray flying from wet feathers.

In Homer (below) a youngster, at right, fights two adult eagles for fish. With no young to feed, immatures can fly farther to find food, though they often rely on scavenging and piracy.

OUR WEBSITE

Experience Sights ■ Sounds of bald eagles and hear behind the scenes tales from photographer Norbert Rosing at **nationalgeographic.com/ngm/0207**.

A [illegible] in Alaska is [illegible] breath [illegible] one bald [illegible] These birds [illegible] decades [illegible] and [illegible] the mantle [illegible] the [illegible] be [illegible]

Somalia

A failed state?

FIGHTING AND FAMINE PLAGUE A NATION WITH NO REAL GOVERNMENT, BUT PRIVATE ENTERPRISE FLOURISHES IN THIS ULTIMATE FREE MARKET.

BY ANDREW COCKBURN

[redacted] OF THE GUN

Local militiamen guard a police [redacted] in Jawhar, where elders and businessmen have brought some law to a town beset [redacted] banditry and feuding.

RICCARDO VENTURI, CONTRASTO

SOMALIA APPEARS to be the very definition of what we call a failed state. The last time this desert country possessed anything approaching a "normal" government, with tax collection, social services, and law enforcement, was under a bloody dictator named Siad Barre. After Barre was driven out by a national rebellion early in 1991, political power over most of Somalia fell into the hands of feuding warlords, who, like grand dukes from the European Middle Ages, deployed their private armies to battle for power even as hundreds of thousands of other Somalis were dying of hunger. Outside intervention, often with good intentions, has done little to help—and has usually made things worse.

Draped around the Horn of Africa, its coasts washed by the Indian Ocean to the east and the Gulf of Aden to the north, Somalia is for the most part an arid land with only two permanent rivers, one of which dries up intermittently. The country is largely flat, except for the low but rugged mountain ranges of the north. Some of the salient features of the landscape and its inhabitants were enumerated a century ago by nationalist leader Mohamed Abdullah Hassan, known to his enemies as the Mad Mullah: "I like war, and you do not," he wrote in a threatening note to the British colonial authorities then occupying the northern part of the country (the Italians colonized the south). "The country . . . is no use to you. If you want wood and stone you can get them in plenty. There are also many ant heaps. The sun is very hot."

Relief from the aridity, at least in good times, comes twice a year, between April and June and October and December, when minimal rainfall replenishes the water holes and briefly blankets the plateau covering the center of the country with grass and wildflowers. Most settled farming is in the south between the Jubba and Shabeelle Rivers, where there is enough constant moisture—except that for the past three years there has been little or no rain, raising the specter of widespread famine. Elsewhere rural Somalis tend their sheep, goats, and cattle along with their camels, which the nomadic herdsmen venerate as "living boulders, placed by God in the wilderness."

Sharing a common language and the Sunni Muslim faith, Somalis are both linked and divided by the pervasive clan system. Each clan traces its descent from a common ancestor in the remote past. Within clans there are family subclans, often bitterly divided against each other. It is to his subclan that a Somali looks for protection against the outside world, and it is the subclan that exacts revenge or compensation for a Somali who is killed. "I and my clan against the world," goes a Somali saying, "I and my brother against my clan."

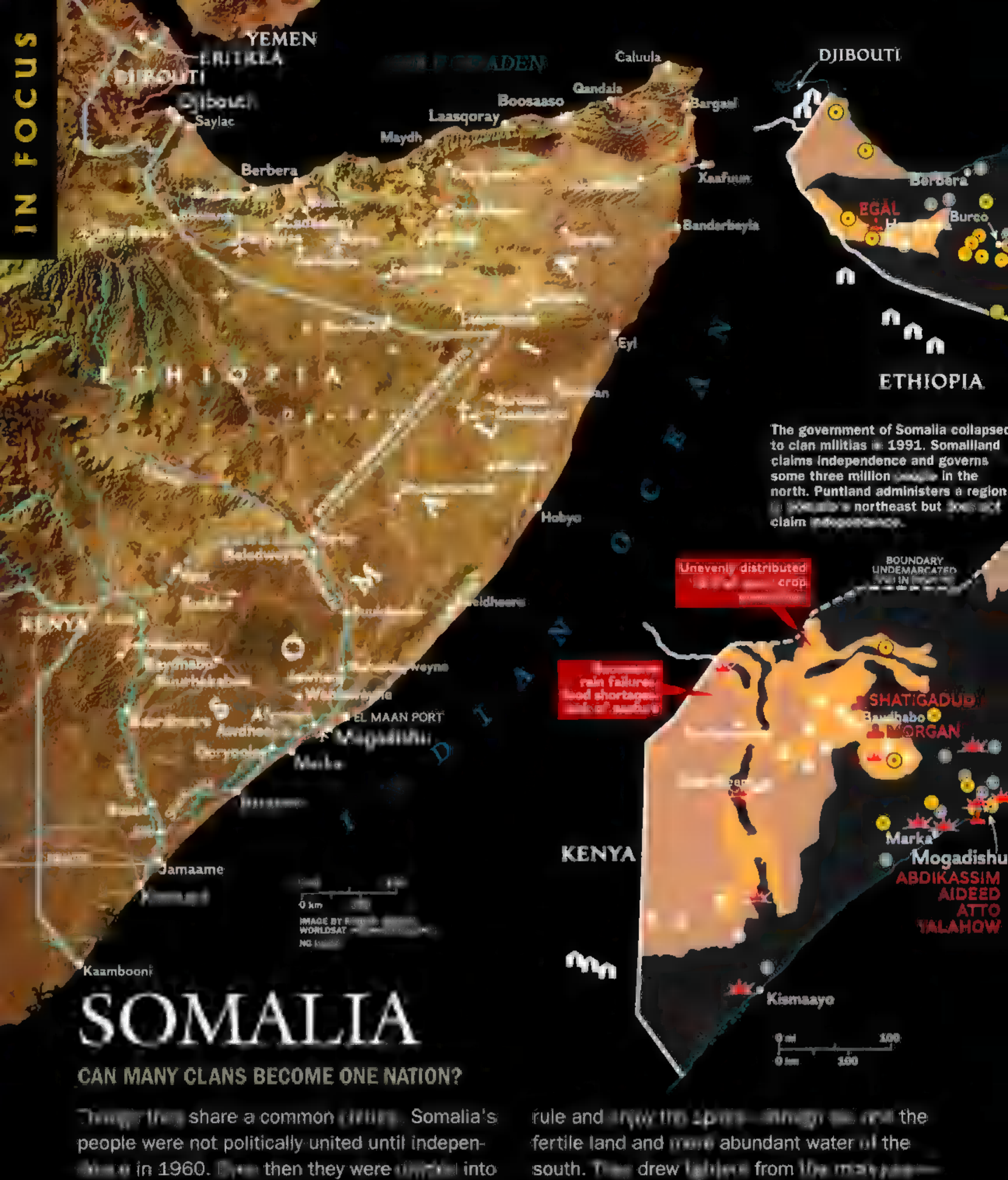
After Siad Barre was overthrown, the existing clan leaders, who traditionally adjudicated disputes within and among clans, lost control to military strongmen who had emerged during the revolt. No one could stop the quarrels of these warlords, who, armed with modern weapons, took over the clans and pillaged the country to supply and pay their private armies. The northwest, where the Isaaq clan predominates, seceded, declaring itself the independent state of Somaliland. It has survived ever since despite minimal resources, a couple of civil wars, and lack of recognition from the outside world. In the northeast the Harti clan of the Darod created a similar entity, Puntland (though without declaring independence), with rather less success.

Meanwhile Somalia's capital city of Mogadishu, now the stronghold of the Hawiye clan, was divided by fighting between its Habr Gedir and Abgal subclans as their respective leaders struggled for power. In 1993 a United States military force, originally dispatched to Somalia as part of a United Nations humanitarian peacekeeping mission in the midst of a horrific famine, concluded that the Habr Gedir leader, Mohamed Aideed, was the principal source of local disorder and launched an intensive manhunt to arrest or kill him. Uniting in the face of this assault on their leader, the Habr Gedir fought back, culminating in the October 3, 1993, battle in south Mogadishu—the subject of the recent film *Black Hawk*

LAW AND DISORDER

A red light directs traffic on [illegible] main thoroughfare in Hargeysa, capital of Somaliland, a breakaway northern province [illegible] a functioning government. To [illegible] south in Mogadishu, anything goes. Money changers in an outdoor market trade Somali shillings, [illegible] have been greatly devalued since [illegible] influx of counterfeit money began in 1996.

TYLER HICKS, GETTY IMAGES (TOP); GUENAY ULUTUNCOK, LAIF/AURORA



SOMALIA

CAN MANY CLANS BECOME ONE NATION?

share a common culture. Somalia's people were not politically united until independence in 1960. Even then they were divided into clans and subclans. After seizing power in 1969, President Siad Barre outlawed clans, as his paranoia mounted, he pitted them against each other. Clans that he targeted as enemies formed armies to overthrow him. When rebel factions succeeded in 1991, they fought over who would rule and how the spoils—drought relief and the fertile land and more abundant water of the south. They drew fighters from the many "dispossessed" young men trapped in poverty under Barre. Their battles continue. Famine and fear continue the looting and farming that once fed Somalia in chronic drought. A refugee urban culture survives on money sent home from Somalis abroad.

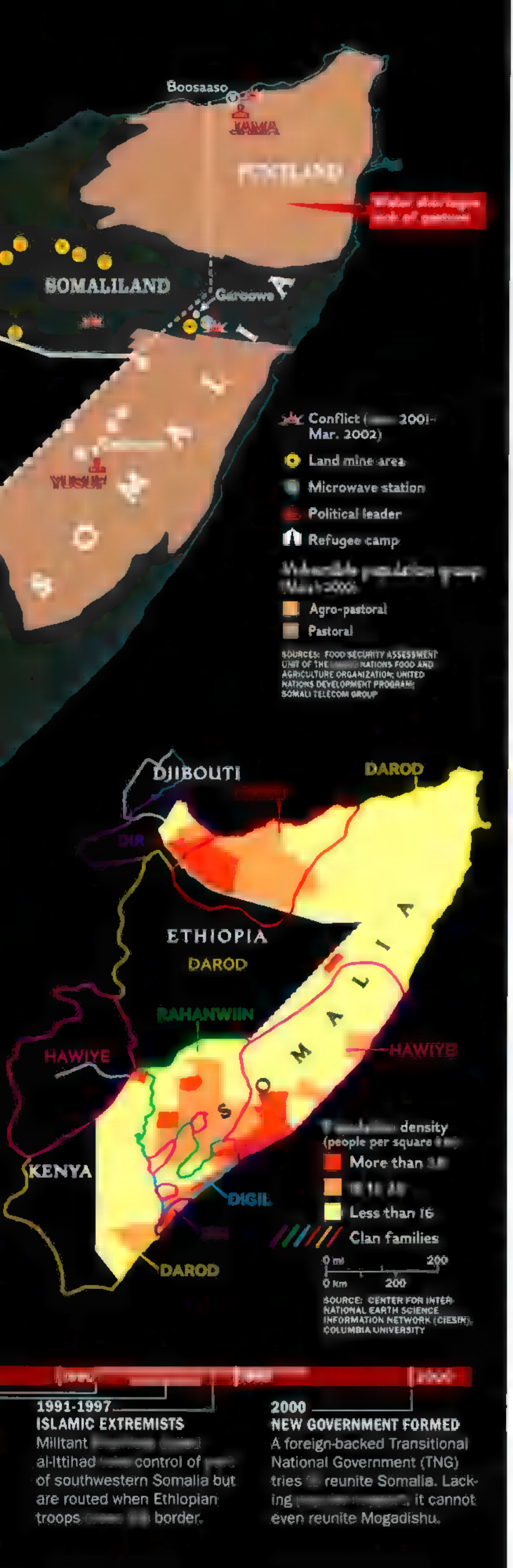
1960

1960
INDEPENDENCE
Italian rule ends. British Somaliland in the north and Italian-controlled Somalia in the south become a single nation: the Somali Republic.

1964-1988
OGADEN CONFLICTS
Somalia's attempts to occupy Ethiopia's Ogaden area, home to an ethnic Somali majority, climax in a loss that undermines Somalia's government.

1991
POLITICAL COLLAPSE
Dictator Siad Barre's 21-year rule ends with clan-based militias driving him from power. Factions vie for control of the south. Somaliland secedes.

1992-1994
U.S.-UN INTERVENTION
Fighting destroy farms and block relief food. An international force arrives after 100,000 starve, then withdraws after bloodshed.



Down—in which 18 Americans and as many as a thousand Somalis were killed.

The shock of American casualties quelled any appetite among Western powers for further intervention. There seemed every reason to expect that Somalia, abandoned by the outside world, would sink into a morass of starvation and war. That has not happened. Instead, like plants sprouting after a forest fire, Somalis have managed to survive and build on their own, in some respects with more success than developing nations on the receiving end of international aid and advice.

In the northwestern city of Hargeysa, in the congested Sheikh Nur community for returned refugees, the Ismail family invested their meager resources in a water tap to supply the entire neighborhood. Abdi Ismail not only garners a weekly profit of $20 but also points out: "We are contributing to rebuilding Somaliland."

Some Somali businessmen engaged in more ambitious enterprises say they have succeeded, at least initially, because of the total lack of oversight and regulation. "We have been through some hard times," admits telecommunications tycoon Abdirizak Ido, "but the worst was when we had a government. Once there was no government, there was opportunity!

"I can say that we have a more efficient communications system than neighboring countries like Ethiopia and Kenya," says Ido, the founder of Nationlink, one of Somalia's ten fiercely competitive telephone companies. "In Mogadishu you get landline service eight hours after you order it—for ten dollars a month." (Cell service is instantaneous.) Local calls are free, and international calls cost 60 cents to a dollar a minute, even from remote villages linked to a phone center by shortwave radio.

With the phone service as pump primer, other businesses have been flourishing in Mogadishu and elsewhere. Gaalkacyo, a desert town in the center of the country, has streetlights, thanks to Abdirizak Osman, a local entrepreneur who branched out from phones to electrical generators, not only lighting the town but also supplying free power to the hospital. Abdul Dini, one of the Nationlink partners (though he and Ido belong to different subclans), rattles off his growing list of subsidiaries: A spaghetti factory in Mogadishu (one legacy of a half century of Italian occupation is the Somali avidity for pasta), a plastics factory,

a mineral-water plant, a bakery. Mogadishu has two fiercely competing cable TV companies, and a (pirated) copy of *Black Hawk Down* was playing in one of the city's cinemas within days of its nationwide release in the U.S.

But where, I asked Dini, does all the money to support this economy come from? There are few exports to speak of, especially since the Saudi Arabian government has twice banned the import of Somali livestock—a particular disaster for Somaliland—on the grounds that the animals are infected with Rift Valley fever, which can be fatal to humans. (UN experts, however, dispute the claim of infection.) Rice, the staple diet, is imported, along with a huge volume of *qat*, the mildly stimulating shrub chewed by many Somalis, flown in daily from Kenya.

"We live off the international community—of Somalis," Dini answered with a chuckle. "That is where all the money in the country comes from." There are more than a million Somalis living and working throughout the world, a diaspora accelerated by the disorders of the nineties. Dutifully conscious of their obligations to family at home, these expatriates send back as much as 700 million dollars a year, "20 million dollars a month into Mogadishu alone," says Dini.

It is a system based entirely on trust. "Ali" in, say, Minneapolis, a U.S. city heavily populated with Somalis, will go to his local Somali money-transfer office and hand over a hundred dollars for his cousin "Ahmed" in Gaalkacyo. (The office will probably know him, at least by reputation, and may front the money if necessary.) The Minneapolis office simply notifies the office in Gaalkacyo by fax to hand the money over to the cousin, and the offices settle up later. Thanks to the phone system, the entire process typically takes about 24 hours.

Until last year the largest such transfer operation was a company called al Barakat, but last November Washington announced that the company had been moving cash for Osama bin Laden and closed it down. Other companies swiftly moved in to fill the gap, but the shutdown bolstered suspicions in the U.S. media that the "failed state" had to be a perfect nest for al Qaeda terrorists.

However, says professor Ken Menkhaus of Davidson College in North Carolina, a UN consultant and expert on Somalia, "There are at this time no terrorist bases or training camps in Somalia." Commenting on reports earlier this year that the al Qaeda leader might be heading for his country, Somali novelist Nuruddin Farah pointed out that if Osama bin Laden turned up in Somalia, he would promptly be cashed in for the 25-million-dollar reward offered by the U.S. government. Farah suggested that bin Laden might want to seek a refuge "where he would be less likely to be sold."

Somalia does have its own fundamentalist Islamic group, al-Ittihad, which made considerable inroads in the early nineties, thanks partly to donations for schools and services coming from Saudi Arabia and the Persian Gulf. Al-Ittihad is still a presence, but, according to many Somalis, the organization has been no match for clan loyalties. "It tried to force its ideology on people," says one Mogadishu businessman, but when al-Ittihad clashed with clan warlords, even al-Ittihad's people supported their clans.

The warlords have also frustrated such Somali political initiatives as the Transitional National Government (TNG), elected by representatives from different clans in August 2000. Despite the attractive possibility of a reemerging national government, the TNG has lacked money and hence authority—its control extends over no more than half of Mogadishu, and does not include the port or airport. Without a central bank to regulate currency, self-serving businessmen have been able to print large numbers of counterfeit notes, which they've used to back the TNG. The result has been the devaluation of the Somali shilling.

Nevertheless, there is a strong appetite for order and stability in Somalia. Commenting on the lack of social life and surplus of armed gangs in Mogadishu, Ido jokes mordantly: "There is no life here—sometimes there is death." Bemoaning the power of the fractious warlords, sponsors of the chaos that first brought him opportunity, he insists that the time is ripe for real government and personally feels that the U.S. could and should impose a political solution. Recent history, however, suggests that Somalis may fare better when left on their own. □

MORE ON OUR WEBSITE

For ■ online interview with author Andrew Cockburn, a list of websites, and news about the latest breakaway region, go to **nationalgeographic.com/ngm/0207**.

GUENAY OLUTUNCOK, LAIF/AURORA (TOP AND BOTTOM); ■ ANGRI, GRAZIA NERI

WAR NO MORE

"[illegible] can only quench your thirst by lifting water with your own hands," says a Somali proverb. In [illegible] (above), newly returned refugees use well water to grow crops [illegible]. In southern Somalia, where conflict has sown terror, an aid group teaches fighters to plant lettuce seeds (right) in the hope that one day they will sow [illegible]

BY PRIIT J. VESILIND PHOTOGRAPHS BY TIM LAMAN

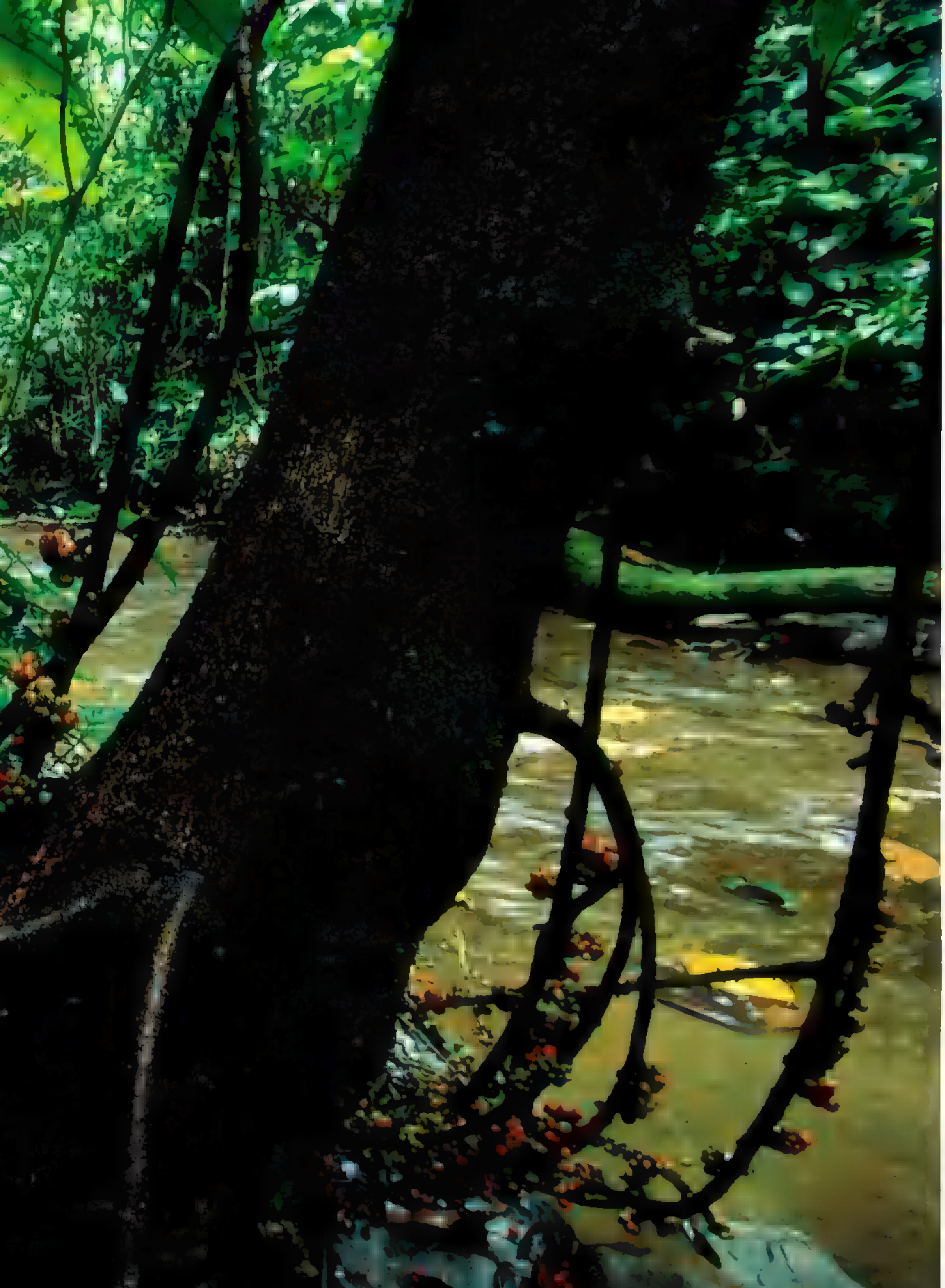
Eye of lizard, wing of bat—a cauldron of fauna and flora boils in the Philippines, one of the world's hotspots of biodiversity. Scientists are still finding new species here, such as this four-foot-long monitor lizard discovered last year on the island of Panay. But habitat loss threatens to erase about 70 percent of the nation's 500-plus species of endemic land vertebrates.

HOTSPOTS

PRESERVING PIECES OF A FRAGILE BIOSPHERE

The Philippines

A wild bounty of figs ripens in the lowland rain forest of the Sierra Madre of northern Luzon. The fruit of this tree, found only in the Philippines, Sulawesi, and Borneo, grows from runners—neither roots nor branches—that issue from the trunk. The Philippine Islands



FICUS MINAHASSAE

were once coated with thick forest that held moisture like a sponge and distributed it gently to springs and streams. Now, due largely to logging and farming, only 7 percent of the old forest remains, and water runs off quickly, bringing successive flood and drought to the lowlands.

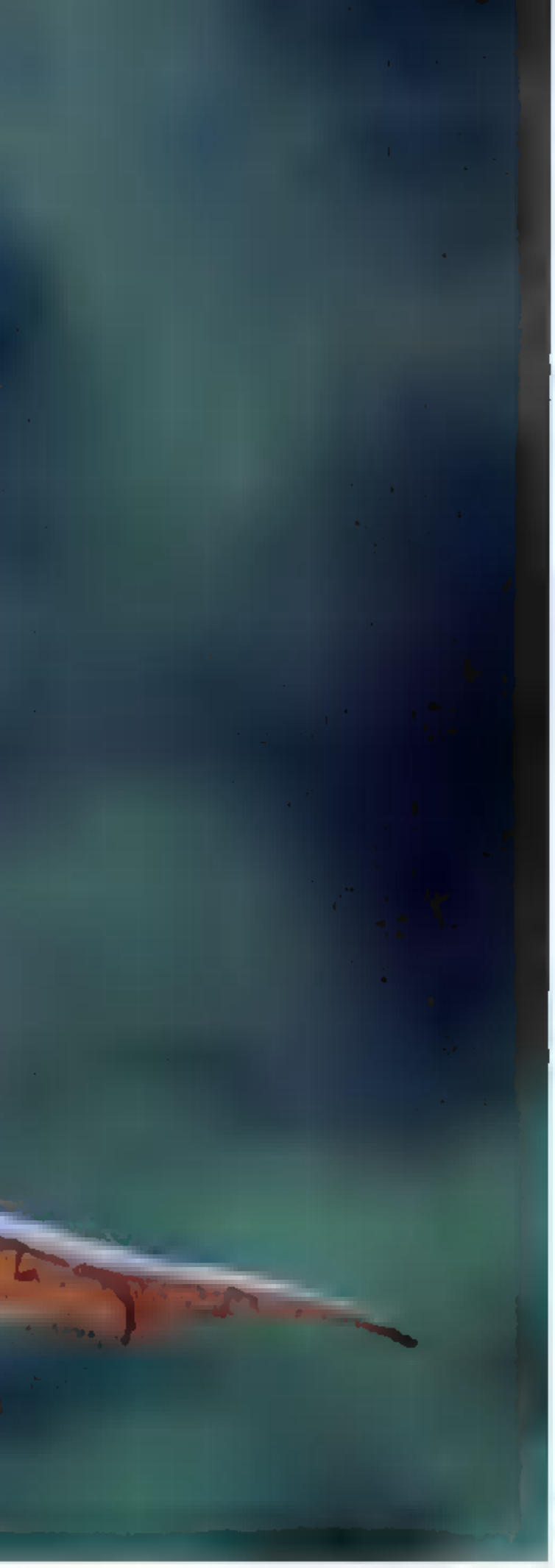
SUN AND RAIN poured down together as the storm passed on the Puyoy-puyoy River, drenching the forest in gold. The leaves of the mangrove tree leaped and sparkled in the downpour, revealing the branch where the python lay. Coiled in ten feet of ready muscle, it merely cocked its head as we slipped by in our outrigger canoe.

The Puyoy-puyoy strains through a towering mangrove forest on the west coast of Palawan, the westernmost province of the Philippine Islands. The river eases into the South China Sea through the Puerto Princesa Subterranean River National Park, where another river flows for five navigable miles inside a cave filled with bats and theatrical limestone formations.

The 15-square-mile park encloses 11 different ecosystems, from the dark, mossy forest of the mountain heights to the blue-water ocean beyond the reef. It shelters a multitude of endangered endemic animals, including the glorious Palawan peacock pheasant. Flying foxes, Oriental small-clawed otters, bear cats, civets, and stink badgers root about its thickness.

To reach this wilderness heart, photographer Tim Laman and I drove north from Puerto Princesa, the muggy capital of Palawan, on a highway that quickly degenerated into a rough gash between rice fields and coconut palms. Smoke rose from piles of burning rice husks; chickens and yellow dogs wandered in the ruts. Limestone karst bluffs loomed like forgotten megaliths, part of a coastal range that slices through the park's protected acres.

Dark clouds bullied in as we reached Sabang, a frontier depot with a grocery store and a few dirt-floor karaoke bars. A water buffalo carted our gear a half mile to the cottages of a "beach resort," where *I lay* hot and moist beneath the mosquito netting as rain pelted



ACERODON

PTENOCHIRUS JAGORI

Skin span propels a bat called the golden-crowned flying fox (left) near Subic Bay in Luzon. Weighing up to three pounds, with a wingspread of 5.5 feet, the blond fruit-and-leaf forager may be the world's heaviest bat. Though reduced to remnants, colonies of these giant bats still keep lowland forests lush by voiding a rain of ingested seeds as they fly. A musky fruit bat (above), native to the Philippines, feeds on figs in northern Luzon's Sierra Madre.

against the thatch, until the house rooster rallied us to a pastel dawn.

I had to rub my eyes. Paradise surrounded us, from the sugary beach and glassy water to the rich forest that sagged above the shoreline, to the soft voices and guitars of the children who sang to us from the kitchen. Outside, the day shift had come on. Bug-eyed mudskippers —amphibious fish—scooted by the tidal pools on short front legs. Dragonflies and small black swallows whirred above. Elegant Palawan hornbills swept in to feed in a tree of ripening figs. Kingfishers and sulphur-bellied bulbuls flapped, twittered, and yawped from the steamy lowland forest.

Later we hiked in, from the glare of the beach to the green translucent light of the understory, where liana vines thick as thighs snaked around lustrous Philippine mahogany, where the air stood shock-still and the humid forest floor smelled like beer brewing. At a ranger camp a six-foot-long monitor lizard, the *bayawak*, emerged from the undergrowth with its gliding, muscular waddle. Strangler fig trees, their smooth bark the color of weimaraners, embraced host trees they would eventually consume.

Said our ranger-guide, Dudes Aguilar, "We think of the host tree like a mother who says to the fig as to her son, 'I will die so you may live.'"

Life and death keep a brisk pace in the Philippines, known as one of the world's 25 biodiversity hotspots, where many species of plants and animals coexist, where an extraordinarily high percentage are endemic, and where many are threatened by extinction. This tropical archipelago of more than 7,000 islands, splashed between China and Indonesia, is often called the hottest of the hotspots, with the loss of many species all but inevitable.

Some biologists feel that the

Philippines' exceptional biodiversity is past the point of saving, but others soldier on. Perry Ong, a vigorous young man who wears a what's-it-to-you rattail in his hair, is the manager of Conservation International Philippines in Manila, a branch of an environmental advocacy organization based in Washington, D.C. He told me, "We still have a small window of opportunity, about 10 years, maybe 15 years, to reverse the degradation of the environment."

Philippine conservationists have managed to designate 1,500 square miles as protected areas, but many of these are too small to ensure the survival of their species. Ong and others feel that Palawan, isolated from population centers, is just beginning to feel the weight of poverty, migration, logging, and industry that has burdened other islands. It could serve as the laboratory for the preservation effort.

"We call Palawan the last unspoiled frontier," said Redempto Anda, director of Conservation International Philippines in Puerto Princesa. "It's also a microcosm of what's happening in the Philippines." With 40 percent of the remaining mangrove cover and 30 percent of the intact coral reefs of the Philippines, Palawan may be the nation's last chance to strike the critical balance between consumption of sustainable resources and their protection.

In Palawan, as in other islands, we found hope in a growing collaboration of government agencies, nongovernment organizations (NGOs), and academic institutions. Together they may bring some equilibrium to what could be a headlong slide toward mass extinctions.

HOT AND FECUND, the Philippine Islands are incubators of life, soaked by both southwest and northeast monsoons, windwhipped by as many as 33 typhoons each year, beset by earthquakes and at least 17 active

Spilled along the Pacific's edge, the 7,000 islands of the Philippines [illegible] from the collision of tectonic plates and volcanic activity. Plants and animals evolved in isolation, migrating to other islands mainly during Ice Age low water. Coral reefs of the Calamian islands in Palawan (left) sustain fishermen in outrigger *bancas*.

volcanoes. The islands emerged from the grind of tectonic plates in the Pacific some 50 million years ago. Their shorelines fell and rose with the ice ages, and they were sometimes linked to one another by land bridges. But the Asian mainland remained hundreds of miles away, except for a few stepping-stone islands. Migration back and forth was impossible for most creatures, so each Philippine island evolved in virtual isolation, with its own unique species.

Forests once carpeted 96 percent of the archipelago's landmass—mangrove swamp, lowland rain forest, montane forest in the foothills, and mossy forest on the summits. That cover has now dwindled to less than 18 percent, with only 7 percent of the original uncut forest left. Commercial and small-time logging for Philippine mahogany, slash-and-burn farming, and mining have nearly ruined some islands, leaving them vulnerable to severe erosion, floods, and droughts. The thin layer of topsoil has simply run into the ocean, and what remains is virtually bereft of nutrients, useless even for agriculture.

This runoff has led to spoiled waters as well. River silt has killed coral reefs by denying them sunlight. Many poor fishermen add to reef destruction by using cyanide to stun and capture live fish for the aquarium trade. Others dynamite the reefs to blast food fish to the surface. Miles of reefs have been bleached by recent El Niño hot spells. The Visayas, the smaller islands wedged between Luzon in the north and Mindanao on the south, are at serious risk of economic collapse.

"Look at Cebu, an island that's 99 percent denuded," said Danilo "Danny" Balete, a biologist with Laksambuhay Conservation, an environmental NGO in Manila. "It's mainly forest over limestone. Now only a tiny layer of soil is left clinging to the deforested areas. You can plant some corn if you're lucky. Once you've

lost the forests, there's no way of regenerating them. They're collapsed ecosystems that can't support people."

Yet the Philippine Islands still teem with people as well as 12,000 plant and 1,100 land vertebrate species—a bounty that Lawrence Heaney, associate curator at the Field Museum in Chicago, calls "Galápagos times ten." Heaney and other scientists are still discovering new species in the Philippines. In 1988 his team rediscovered a rare small mammal seen only once before in the mossy rain forests near Mount Isarog, in southern Luzon. Popularly known as the Isarog shrew-rat, later named *Rhynchomys isarogensis*, it is built like a tiny kangaroo, with strong haunches and a pointed snout, and eats almost nothing but earthworms.

Other scientists have sought to bolster populations of endangered, endemic flagship species, those that most vividly represent the biological wealth of the Philippines. On Bohol Island the Philippine Tarsier Foundation has bred and released some 20 tarsiers, five-inch-tall nocturnal primates with owlish eyes and Yoda smiles.

HOTSPOTS

The Earth's richest and most threatened reservoirs of plant and animal life

THE PHILIPPINES

AREA 115,831 sq mi

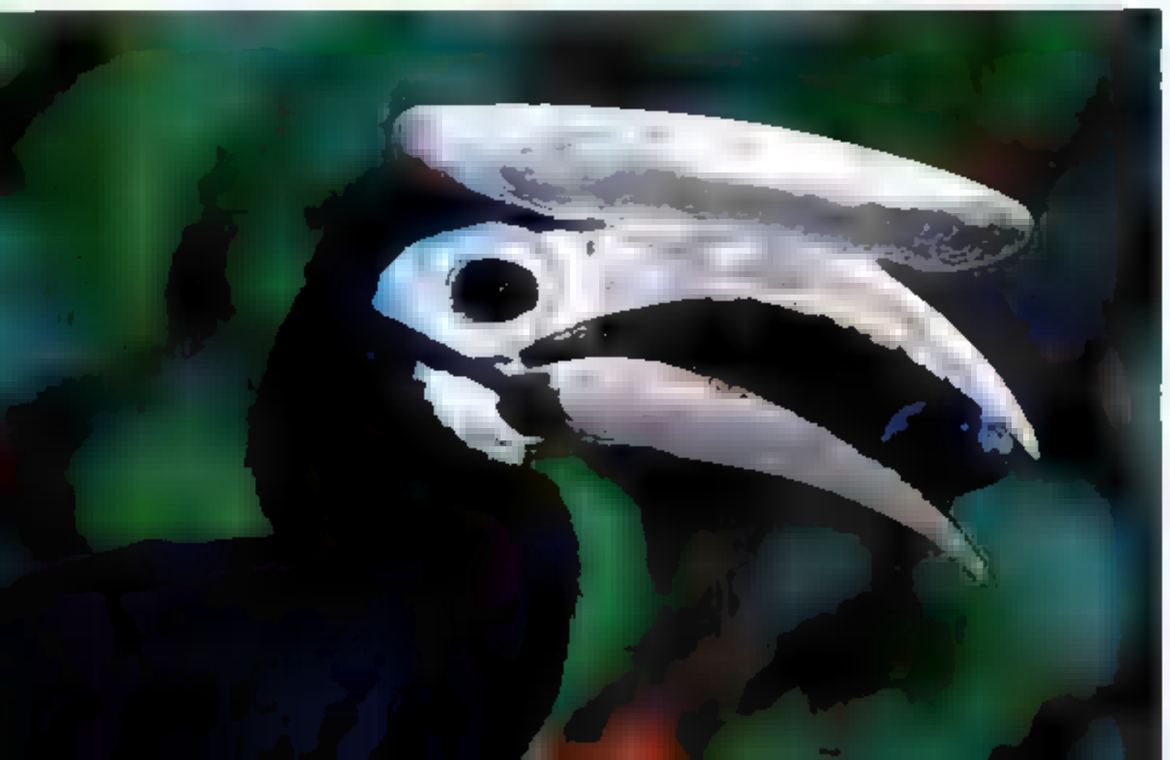
HABITAT TYPES
Lowland rain forests, montane forests, coral reefs, mangrove coasts

FLAGSHIP SPECIES
Philippine eagle, Philippine tarsier, Philippine dwarf crocodile

ENDEMIC SPECIES
6,000 plants, 111 mammals, 172 birds, 108 amphibians

PRINCIPAL THREATS
Cyanide and dynamite fishing, logging, mining, slash-and-burn farming

CEYX MELANURUS (KINGFISHER), *ANTHRACOCEROS MARCHEI*



Endemic species result from isolation, but what causes the overall immense variety of life in the Philippines? A high production of biomass from constant and abundant moisture and solar energy is one factor, as is the fact that mountainous tropical islands create a host of different growing conditions, or microenvironments, at different altitudes, where very specialized plants and animals find their niches.

More than 100 species of trees often grow on a single slope of rain forest and 500 species of coral on a single dazzling reef. The high forests, thick with gnarled trees and dense mosses, hold rainfall like a sponge and allow it to percolate gently into springs and streams. A cool fog constantly sifts through the trees, leaving vegetation dripping. These mossy forests hold the highest concentration of endemic flora and fauna in the Philippines.

What threatens species most is loss of forest cover. Of the 283 endemic species of mammals and birds in the Philippines, half are endangered. Dramatically tufted Philippine eagles, one of the world's largest, survive only in lowland forests on a few islands. A remnant population of tamaraus, elusive dwarf water buffalo, remains on the island of Mindoro. Slender-tailed cloud rats, meaty and as big as house cats, have been heavily hunted in the Visayas.

"Acre for acre," said Heaney, "the Philippines may have the most seriously threatened flora and fauna on Earth."

MANY OF THE environmental problems in the Philippines have social roots. Colonial exploitation by Spain and then the United States, as well as homegrown corruption, has left wealth in the hands of a small ruling class.

"We have two major users of the resources—those privileged few who exploit the resources for profit and the majority who exploit the resources for subsistence," said Danilo Balete.

NATIONAL GEOGRAPHIC, JULY 2002

Rarely seen, a Walden's hornbill perches near its nest hole. Found only on the islands of Panay and Negros, the bird may be close to extinction. A five-inch-long Philippine dwarf-kingfisher (facing page, top), endemic to the Philippines, was netted in a scientific survey and photographed in hand. The fig-munching Palawan hornbill (facing page, bottom) survives only in that westernmost province.

ACEROS WALDENI

PITHECOPHAGA JEFFERYI

Running out of room, the endangered Philippine eagle, one of the world's largest, needs broad forests to survive. At the Philippine Eagle Center on Mindanao, Eddie Juntilla (above) trains an eagle raised in captivity for artificial insemination. Many Filipinos must choose between conservation and food on the table. A woman in Panay (right) resorts to planting rice in the rocky soil of a forest charred by destructive slash-and-burn farming.

Many bone-poor Filipinos have fled degraded islands for relatively intact havens such as Palawan. But their desperation travels with them. Although polluting industrial plants make more headlines, much environmental damage is done in little bits by anonymous, needy people forced into the simple daily choice between conservation and food in the belly.

"Every day we get reports of illegal quarrying, illegal logging, illegal fishing," said Grizelda "Gerthie" Mayo-Anda, a 41-year-old native Palawan dynamo who founded and now heads a group of crusading lawyers called the Environmental Legal Assistance Center (ELAC). "But most of these people have fled from sheer poverty, militarization, and conflict. They need help." Offering alternative ways to survive—from ecotourism and handicrafts to fishing and food processing—must accompany conservation measures that restrict the harvesting of endangered natural resources.

Mayo-Anda, demure as a schoolgirl in prim gold-wire glasses, minces no words about the government: "The Philippines has some of the most progressive environmental laws in the world, but the government doesn't provide the money or political will to implement them. Without that, laws become mere rhetoric."

In 1996 ELAC came to the rescue of a community of indigent fishermen on Honda Bay, near Puerto Princesa. Mostly migrants to Palawan from the Visayas, they had built their shanties on a tourist boat jetty that the city had constructed from the toxic tailings of a spent American-owned mercury mine. Sickness followed, but some 2,000 people stayed. Most of them overfished and abused the waters with cyanide and dynamite until the catches of tuna, mackerel, grouper, and *zuno* plummeted to disastrous levels.

ELAC helped the fishermen organize the Honda Bay Boatmen's Association to take

advantage of the quickening tourist trade. On a rotating basis each fisherman would ferry sun-seekers to nearby island resorts, such as Dos Palmas, and fish on other days. The new business proved more lucrative than sneaking cyanide to the coral reefs. It relieved pressure on the bay, led to more robust catches, and pulled many from poverty.

But on May 27, 2001, the Philippines' Islamic terrorists, Abu Sayyef, raided Dos Palmas and abducted 22 tourists for ransom. To make their point, they beheaded one of the tourists, an American. The raid, followed by the September 11 attacks in the United States, virtually shut down pleasure travel to the Philippines.

The collapse of tourism has serious environmental implications for the Philippines: Loss of tourist-related income may drive indigent people back to destructive farming and fishing. When I arrived at the jetty to meet members of the boatmen's association, the roadside souvenir stands were stale with unsold goods. The spidery *bancas*, outrigger fishing boats, were idle. No travelers, only heavily armed policemen, milled about the boat dock.

"The tourists are still scared," said Edwin Bermejo, one of the association's organizers. "Abu Sayyef came here once, and everybody is paying for it." He studied his rough, sandaled feet. "We're back to full-time fishing, but it's not enough. Families are in trouble here, and some have gone back to the old ways. With dynamite you can catch two to four times as many fish."

And yet a new, crucial awareness seems to have settled on the community, a realization that conservation works on behalf of the disadvantaged. "Right now we're poor, but it's better for us to have a typhoon than to have illegal fishing," said Myrna Rosco, a middle-aged widow. "After a typhoon the fish are still there." *(Continued on page 78)*

GASTERACANTHA SPATHOGLOTTIS KIMBALLIANA (ORCHID) MYRMARACHNE PLATYMANTIS (FROG)

Dazzle and bluff: A thumb-size spiny-backed spider flaunts fake horns (left) to look fierce and inedible. A yellow orchid, one of the 631 orchid species native to the islands, invites pollinators with its vivid hue. By using two legs to simulate antennae, a jumping spider mimics an ant to avoid being eaten by spider-loving predators. The Panay cloud frog is one of more than 90 island species whose survival—or extinction—indicates the health of the environment.

Life-giving sun penetrates Apo Reef north of Palawan, where a bouquet of damselfish and other reef dwellers dart around a garden of hard corals. More than 500 coral species and 34 kinds of endemic fish thrive on pristine Philippine reefs, often called the rain

CHROMIS SPP. AND *POMACENTRUS* SP. (DAMSELFISH); *ACROPORA* SP. (HARD CORAL)

forests of the sea. In such reefs scientists have found chemicals for medicines, yet more than 90 percent of Philippine reefs have been damaged by agricultural runoff, dynamite fishing, or cyanide poisoning used to stun and capture live fish for aquariums and Asian restaurants.

TO FIND HEALTHY REEFS, I flew from Puerto Princesa—above green mountain ridges and shaggy-topped islands that looked like stakes pounded into the sea—to the Calamianes, a sprinkling of islands off Palawan's northern tip. Although some 85 percent of these islands' coral reefs have been damaged, pockets of pristine reef remain.

The prop plane buzzed a herd of humpbacked zebu cattle as it settled on the island of Busuanga, where a jeepney, one of those sheet-metal buses loopy with chrome and painted exotica, took me to the town of Coron. There I caught an outrigger to an island resort, Discovery Divers, run by a curly-haired and affable German, Gunter Bernert.

Here, too, the exuberance of life pressed down on the cottages. The liquid warble of a bulbul bird awakened me in the morning, and something big and invisible in the thatched ceiling grunted loudly. From the surrounding bamboo thicket came low, hollow hoots, as if someone were blowing into an empty bottle. And an army of ants had trooped from a crack in the bathroom wall and attacked my toothbrush.

A half dozen such diving resorts surround Coron. Some rope off and guard their reefs from local fishermen. These "house reefs" ensure many fish and quality snorkeling for guests but irritate the community. I had asked Edward Lorenzo, a young ELAC lawyer, if the resorts, in fact, weren't practicing good conservation.

The question provoked him because it touched on a key conservation issue in developing nations like the Philippines. Is conservation good when it denies poor people sustenance? No, he said, human rights must accompany conservation. "As long as there are poor people, there will be threats to the environment, but when you allow resorts to set up boundaries on the sea, you threaten the

OPISTOGNATHUS SP.

ETHUSA SP. (CRAB), CASSIOPEIA ANDROMEDA (JELLYFISH)

Scrambled eggs—its own—fill a jawfish's mouth, a convenient place to protect the nearly hatched brood from predators while still allowing water to circulate and provide oxygen. When feeding, the jawfish hides the eggs in its reef hole. Forming an odd couple (above), a crab uses its hind legs to clutch an upside-down jellyfish for camouflage or defense. A red-banded wrasse (below), just one species of this large family of reef fish, buries itself in the sand to escape nocturnal reef rovers. One animal grazing on another, a nudibranch, or sea slug (bottom), feeds on a colonial tunicate, which glitters like the jeweled branch of a fantastic tree.

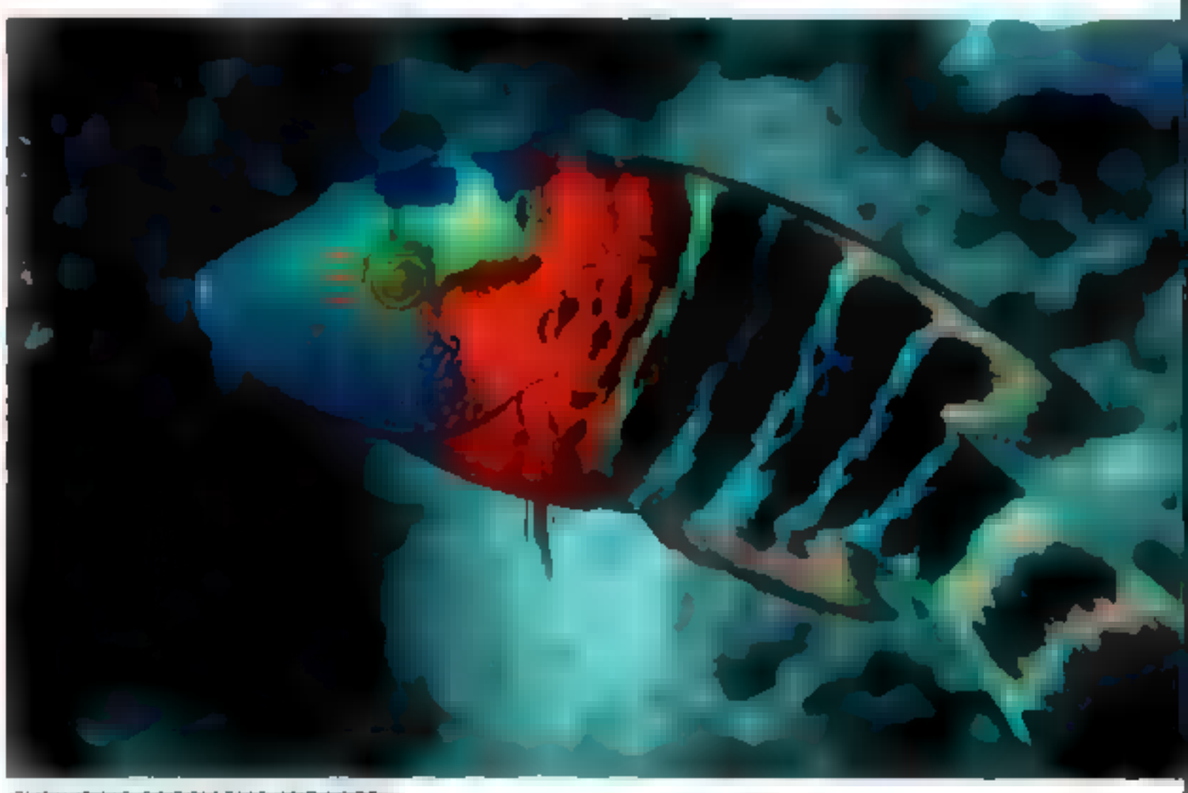
livelihood of small-time fishermen. You have too many people who depend on those resources, people who live by the fish in the seas."

This was not a contradiction, he said, but a balancing act. If subsistence fishermen have the right to fish, they also have the obligation to sustain the fishing grounds.

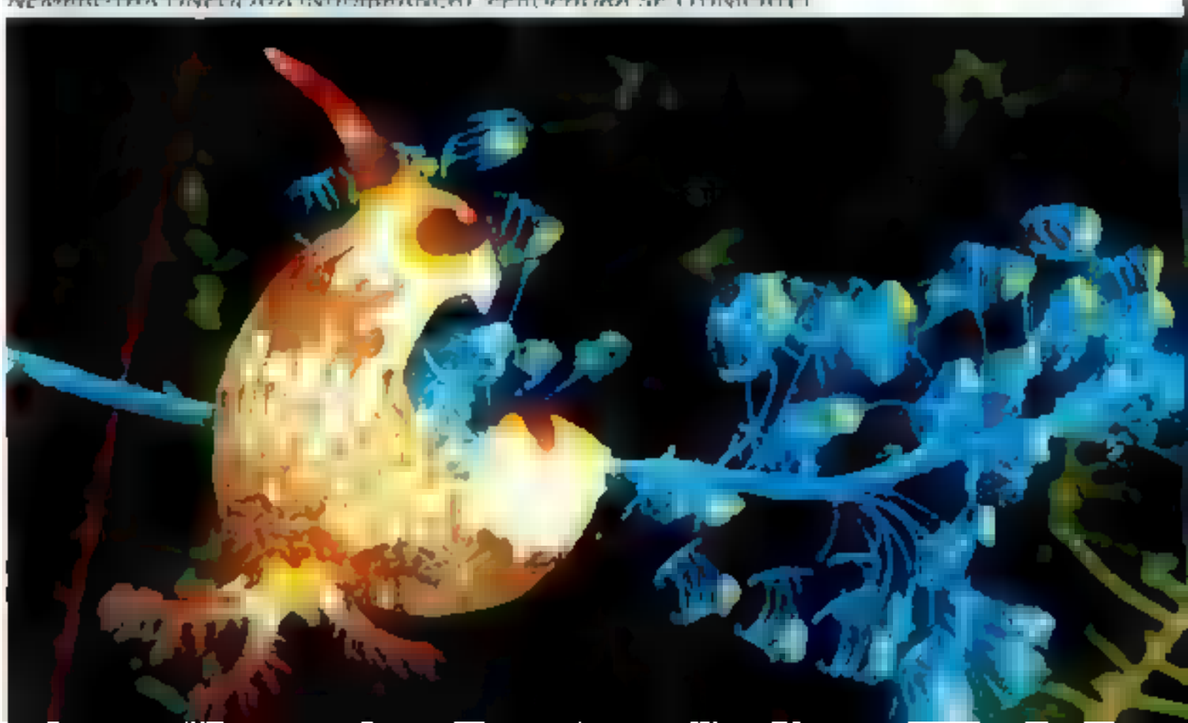
On healthy islands a continuum of high biodiversity carries from mountainside to seafloor, and one morning I saw the entire scope of it. I flew in an ultralight aircraft along the thickly matted slopes of the islands, seeing how the coral reefs that wreathe the islands shine like irises in bright eyes. When the aircraft alighted on the water near our dive boat, I kayaked over, slipped on my scuba gear, and sank into the warm water to continue my flight from one divinely liberating medium to another.

We dived for five days off Coron, among some of the most vibrant reefs left in the Philippines, phantasmagorias worthy of Dr. Seuss.

THE PHILIPPINES



CHEILINUS FASCIATUS (WRASSE); NEMBROTHA LINEOLATA (NUDIBRANCH); PEROPHORA SP. (TUNICATE)



Too cute

for its own good, the moon-eyed Philippine tarsier is hunted and sold as a pet on Bohol and nearby islands. The kitten-size nocturnal primate survives in second-growth forests, but its habitat continues to shrink. Scientists agree that only quick, strong action will save such Philippine species from extinction in the coming decades.

TARSIUS SYRICHTA

A living reef inhales and exhales with sucking, grasping, filtering animals. Periwinkles, brittle stars, and black long-spined sea urchins, like evil sprites, bristle in the shallows. Translucent wands of anemones wave in the current. Corals parade down the slope—whip corals, mushroom corals, brain corals, fan corals as intricate as lace mantillas.

Above the corals are the free swimmers—gaudy sea worms flapping like magic carpets, a feather star crinoid mincing like a duster brought to life by a wizard. A crab carrying an upside-down jellyfish on its back as defense or camouflage. Lizard fish, pufferfish, parrotfish, angelfish, butterfly fish, fake clownfish, real clownfish. Shy schools of yellow-tail trevally. Batfish, nearly twice as tall as they are long. The gleefully named spotted harlequin sweetlips.

But there was no escaping the damage. We found reefs as anemic as burned forests and others where leafy cabbage coral lay in fragments, coleslawed by dynamite or carelessly tossed anchors. Once destroyed, coral reefs take 20 to 30 years to heal and recover.

"When you look at the percentage of damaged reef, it seems hopeless," said Rannie Dulay, a Coron wilderness guide and conservationist, "but when you look at the diversity of life there, you feel a strength." Dulay smiled and brandished his fist. A slight man of 34, he has organized a program to help fishermen rebuild their reefs.

Already six communities have taken matters into their own newly educated hands. They've stopped spreading cyanide. They're allowing damaged reefs a recuperation period, then they plan to transplant coral fragments raised in shallow-water farms, much as rice seedlings are transplanted. Recovered reefs mean healthy fish populations and increased tourism in this gorgeous corner of the Philippines.

WHEN WE DIVED the next day close to Coron Island, we were confronted by an outrigger of Tagbanuas, a tribe of aboriginal Filipinos, wanting 75 pesos a head (about $2) for using their waters. The Tagbanuas of Coron are the first indigenous group in the Philippines to be granted both land and water rights in their ancestral domain. They have divided Coron, 86 square miles of rain forest, lakes, and coral reefs, into two parts—one a sacred area, the other open to a limited number of visitors. Visas are required, those 75 pesos each, to the consternation of resort operators who once made money taking guests to freshwater Kayangan Lake on Coron Island, a site both sacred and vital to the Tagbanuas.

We sailed toward the Tagbanuan village of Cabugao one morning, plodding through a hundred yards of muddy tidal flats to reach the coastline of mangroves. An elder, Solomon Aguilar, sent a man up a palm tree in his front yard and offered us its cool coconut water.

The Tagbanuas live mostly off their surroundings. They fish only by hook and line or with a spear. They grow cashew nuts and gather the nests of swiftlets in cliffside caves. As they have done since the 15th century, they sell the nests, made of bird saliva, to Singapore, Hong Kong, and Japan as the main ingredient of bird's nest soup.

The birds are very finicky. They like to drink the clean water from Kayangan Lake. The Tagbanuas need to restrict visitors because the lake will become polluted by suntan lotion and insect repellent.

The Tagbanuas have little access to modern medicine but gather herbs and roots in the forest when they are sick. They use guava leaves for upset stomach and know how to prepare *korot*, an otherwise poisonous sweet potato. They have discovered a substance that stuns reef fish without cyanide.

The possibility that other critical medicines or drugs may be locked in reefs or rain forests has always been one compelling reason to safeguard diversity. A key chemical in AZT, a drug used to treat patients with AIDS, was found in a coral reef; rosy periwinkle from a Madagascar forest has been highly effective in fighting childhood leukemia. Scientists can only guess at the potions and ointments that could emerge from the lush environment of Coron.

We sailed back from Cabugao at dusk in a cool breeze. The outrigger sliced through waves that glowed with the phosphorescence of small plankton. A crescent moon seeped into the dark water. Perhaps, just perhaps, this paradise has a chance. For this night, at least, a sweet equilibrium hung over the islands. □

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Are hotspots an effective way of preserving biodiversity? Share your thoughts on our forum board at **nationalgeographic.com/ngm/0207**.

The H. L.

DEALING A DEATH BLOW to the [illegible] sloop, the H. L. Hunley in 1864 became the first submarine in history to [illegible] She then [illegible] Divers [illegible] the doomed sub 131 years later, her crewmen—and clues to their fate—still sealed inside.

HUNLEY

SECRET WEAPON *of the* CONFEDERACY

By GLENN OELAND
NATIONAL GEOGRAPHIC ARTICLES EDITOR
Photographs by IRA BLOCK

IT WAS A HUNGRY TIME in Charleston, South Carolina, those early months of 1864. Bombarded by land and blockaded by sea, the city that cheered the opening shots of the American Civil War remained proudly defiant, but its Rebel defenders were looking mighty pinched. Salt pork, corn, boots, blankets, lead for musket balls, and most everything else the army needed was in critically short supply. The Union Navy's chokehold on the city's harbor would have to be broken soon, and the best hope for doing that lay with a strange and secret new weapon—a "diving torpedo-boat" christened the *H. L. Hunley.*

Shortly after sunset on the night of February 17, at a dock on nearby Sullivans Island, eight audacious Confederates squeezed inside the claustrophobic iron vessel and set out on a quixotic mission. Affixed to the boat's bow was a spar tipped with a deadly charge of black powder. At the helm was Lt. George Dixon, a bold-hearted, battle-scarred army officer. Behind him, wedged shoulder to shoulder on a wooden bench, sat seven crewmen whose muscles powered the sub's hand-cranked propeller. As the crew began turning the heavy iron crankshaft, Dixon consulted a compass and set course for a daunting target—the steam sloop U.S.S. *Housatonic,* stationed four miles offshore. The Rebels' plan was to run about six feet below the surface until they neared the blockader. But in order for Dixon to take final aim, he would have to resurface just enough to peer through the sub's tiny forward viewport.


LOUISIANA STATE MUSEUM

"MISTERY. . . is more dreadful than any understood evil," wrote Horace Lawson Hunley of the stealth weapon he helped develop. A Confederate to the core, Hunley believed submarines could save the underdog South by breaking the Union blockade of southern ports.

At 8:45 p.m. John Crosby, acting master aboard the *Housatonic,* spotted something off the starboard beam that looked at first like a "porpoise, coming to the surface to blow." There had been warnings of a possible attack by a Confederate "infernal machine," and Crosby was swift to sound the alarm. Sailors rushed to quarters and let loose a barrage of small arms fire at the alien object barely breaking the surface, but the attacker was unstoppable.

Two minutes later the *Hunley* rammed her spar into the *Housatonic*'s starboard side, well below the waterline. As the sub backed away, a trigger cord detonated the torpedo, blowing off the entire aft quarter of the ship. It was an epic moment.

"This was the first time in history that a submarine succeeded in sinking an enemy warship," says Robert Neyland, head of underwater archaeology for the U.S. Navy and the *Hunley* project director. "The *Hunley* is to submarine warfare what the Wright brothers' airplane is to aviation. It changed the course of naval history."

But while the Wright Flyer would become a famous icon, the *Hunley* was fated to become an obscure footnote. Though she accomplished

her historic mission, she never returned to shore. Her fate, and that of her crew, became one of the Civil War's great mysteries.

AT **PRECISELY** 2 a.m. on the morning of August 8, 2000, at another dock on Sullivans Island, photographer Ira Block and I boarded a boat bound for sea. Along with the pungent smell of the surrounding salt marsh, the night air carried a kind of Christmas Eve excitement. Or maybe it was more like Easter, for when morning dawned the *H. L. Hunley* would rise from her grave.

Anticipation of "recovery day" had been building since May 1995, when a group of shipwreck hunters led by adventure novelist Clive Cussler discovered the long-lost sub outside Charleston Harbor, buried under three feet of silt only a thousand feet from the spot where she ambushed the *Housatonic.* During the five years since the discovery, a team of archaeologists and engineers had been laying plans for the sub's recovery and preservation. In recent weeks crews had been working around the clock, making ready for the moment when a crane barge named the *Karlissa B* would lift the Civil War submarine into another century.

The night crew looked sleep deprived and stubble faced as they welcomed us aboard the *Karlissa.* Among them was Mark Ragan, a diver, submarine devotee, and the *Hunley*'s foremost historian. Standing at the barge's

railing, peering out at an ocean as black as an inkwell, he talked about the effort and ingenuity that produced the granddaddy of the modern submarine.

"The *Hunley* was cutting-edge technology in the 1860s, as advanced for that period as our spacecraft are today," he said. "Remember that this was seven years before Jules Verne published *Twenty Thousand Leagues Under the Sea*. That's how far ahead of their time these guys were."

"These guys" would be Baxter Watson and James McClintock, partners in a New Orleans machine shop, and Horace Lawson Hunley, a Louisiana lawyer with deep pockets and even deeper devotion to the cause of southern independence. Their collaboration eventually produced three pioneering submersibles, each one more sophisticated than its predecessor. The first had to be scuttled to prevent its falling into Union hands, and the second was lost in heavy seas. Though the disasters cost no lives, the financial loss was severe enough that Hunley and his companions had to look for additional backers to make a third try. They found them in a band of mechanical-minded adventurers known as the Singer Secret Service Corps, a kind of Rebel underground.

"This group was involved in mining harbors and railroad sabotage," Ragan said. "They had a contract with the Confederate government that entitled them to 50 percent of the value of any Union property destroyed by one of their inventions."

In addition to the Singer operatives, two Confederate military engineers also lent their expertise to the project: Lt. William Alexander, a mechanical engineer, and Lt. George Dixon, who had worked as a steamboat engineer. The pooled brainpower of this coterie produced a formidable engine of war.

Larger yet sleeker and faster than the earlier prototypes, the *Hunley* was built during the spring of 1863 in Mobile, Alabama, then sent by train to Charleston, accompanied by her owners and designers. Charleston's vital harbor was under heavy siege, its fortifications being reduced to rubble by Union ironclads and shore batteries. With the blessing of Gen. P. G. T. Beauregard, the dashing Creole in charge of the city's defense, the *Hunley*'s builders began making nighttime forays into the harbor, but after two weeks they had failed to score a hit. Meanwhile, Charleston's defenses continued to crumble. Impatient for bold action, the city's military authorities commandeered the submarine and manned her with Confederate sailors, whose inexperience soon proved fatal.

By one account the new skipper, Lt. John Payne, unfamiliar with the sub's operation,

RISING from her grave like the ghost of a Confederate veteran, the Hunley*—securely ensconced in a cradle of steel beams and padded slings—breaks the surface before boatloads of spectators. "People from all over the world came to see this event," says archaeologist Harry Pecorelli (below right, in foreground). To ensure a safe lift for two snorkels from the sub's air-intake system, Pecorelli and National Park Service archaeologist Matt Russell had lashed the pieces to a backboard.*

> *"The* Hunley *is to submarine warfare what the Wright brothers' airplane is to aviation. It changed the course of naval history."*

SOCIETY GRANT

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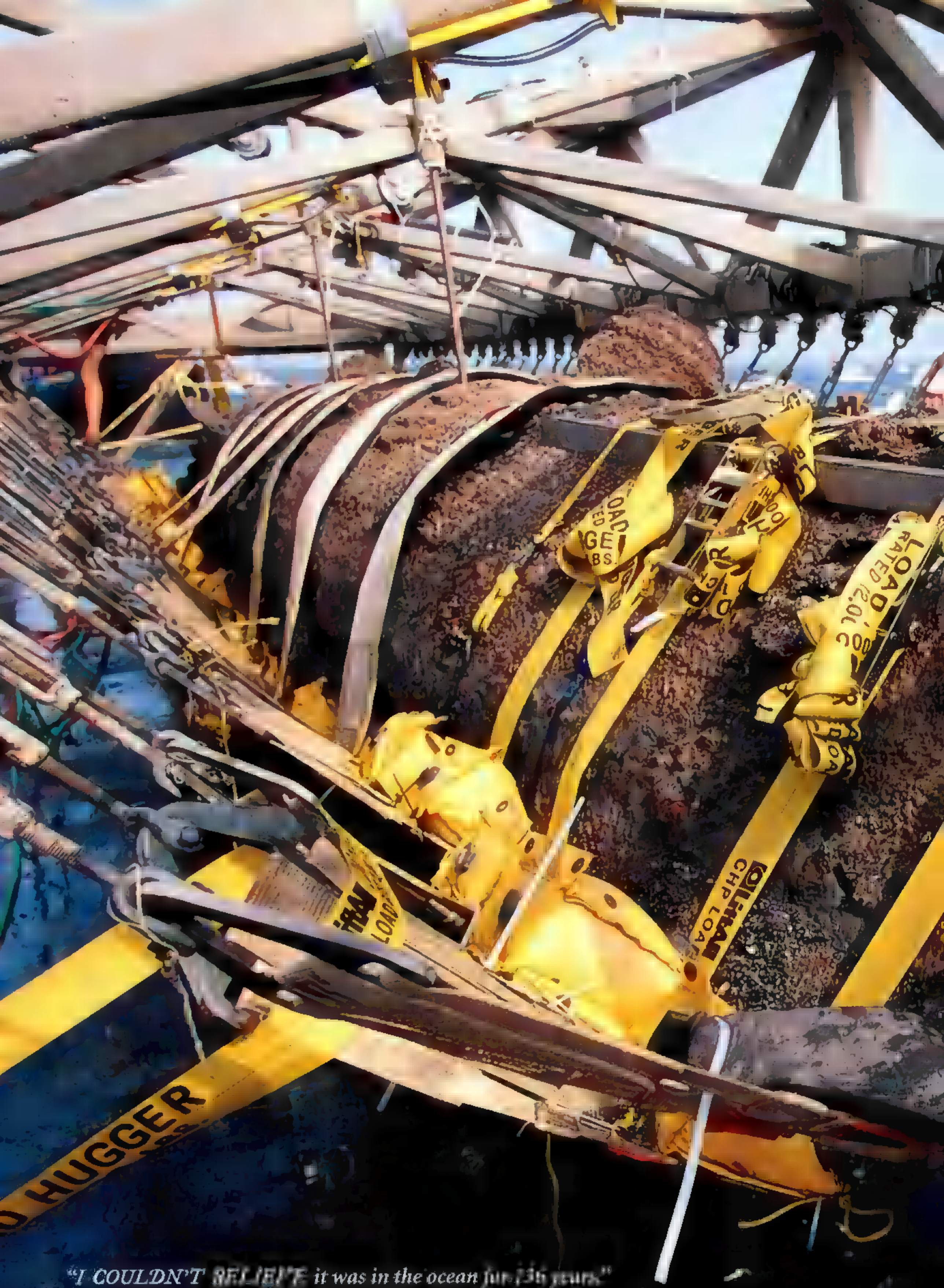
HUNLEY



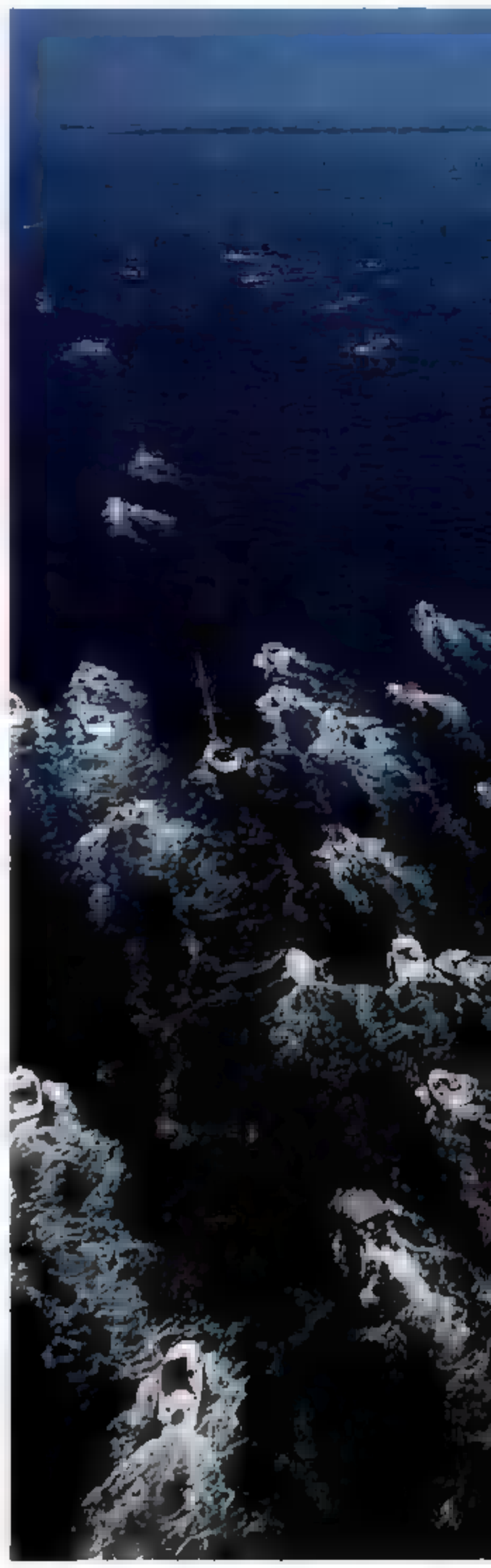
"I COULDN'T BELIEVE it was in the ocean for 35 years," said chief conservator Paul Mardikian, marveling at the condition of the Hunley's iron hull. Corroding iron combined with minerals and marine organisms to create a rock-hard rind. Then, within about 20 years, the sub was buried by preserving silt.

caused her to dive before the hatches were secured. Another version has it that the sub was swamped by the wake of a passing steamer. Whatever the cause, five of the nine crewmen drowned.

Two weeks elapsed before divers in heavy copper helmets managed to raise the submarine from the bottom and get her ashore, by which time her occupants were so bloated that they had to be dismembered and removed in pieces. Their severed limb bones, unearthed in 1999 when archaeologists excavated their graves, still bore the marks of the saw.

Horace Hunley, undeterred by the grisly fate of the five sailors, persuaded Beauregard to turn the submarine back over to him and his comrades from Mobile. But apparently Hunley either overestimated his own captaining skill or underestimated how unforgiving the sub was of pilot error. During a training mission just six weeks after the first accident, Hunley himself was at the helm when the boat again went to the bottom, killing all eight men inside. Evidently Hunley had failed to close a flood valve, causing a ballast tank

"They'd crank for hours and get maybe six or eight miles offshore. Then they'd have to turn around and crank all the way back."



ESCORTED by a fleet of well-wishers, the Hunley *is towed between two tugs on her final voyage into Charleston, where crowds lined the waterfront to glimpse the storied submarine. "The* Hunley *is like the* Titanic*—she was lost and found," says Glenn McConnell, chairman of the South Carolina Hunley Commission. As a crane hoists the sub ashore (below right), reenactors salute its fallen crew. Says one, "We came to focus on the humanity rather than the iron."*

to overflow into the crew compartment.

Once more divers rigged chains to the sub, hauled her ashore, and opened the hatches. "The spectacle was indescribably ghastly," wrote General Beauregard years later. "The unfortunate men were contorted into all kinds of horrible attitudes . . . and the blackened faces of all presented the expression of their despair and agony."

Along the Charleston waterfront sailors began referring to the submarine as the "murdering machine" and joking that it "would sink at a moment's notice and at times without it." For his part, George Dixon would hear none of it. His confidence in the boat that he had helped build was unassailable. With Horace Hunley dead, Dixon appealed to Beauregard to let him take command.

"I can have nothing more to do with that submarine boat," came the exasperated general's written reply. " 'Tis more dangerous to those who use it than to enemy."

But Dixon persisted, his coolheaded determination eventually winning Beauregard over. With the submarine refitted for action, Dixon and his new first officer, William Alexander, went aboard the C.S.S. *Indian Chief* seeking volunteers to recrew the boat. Beauregard had issued a strict order that all recruits were to be made fully aware of the "desperately hazardous nature of the service required." If the submarine didn't kill them, the Yankees would be happy to oblige. And Admiral John Dahlgren, commander of the Union blockade, had declared that captured submariners deserved to be hanged "for using an engine of war not recognized by civilized nations."

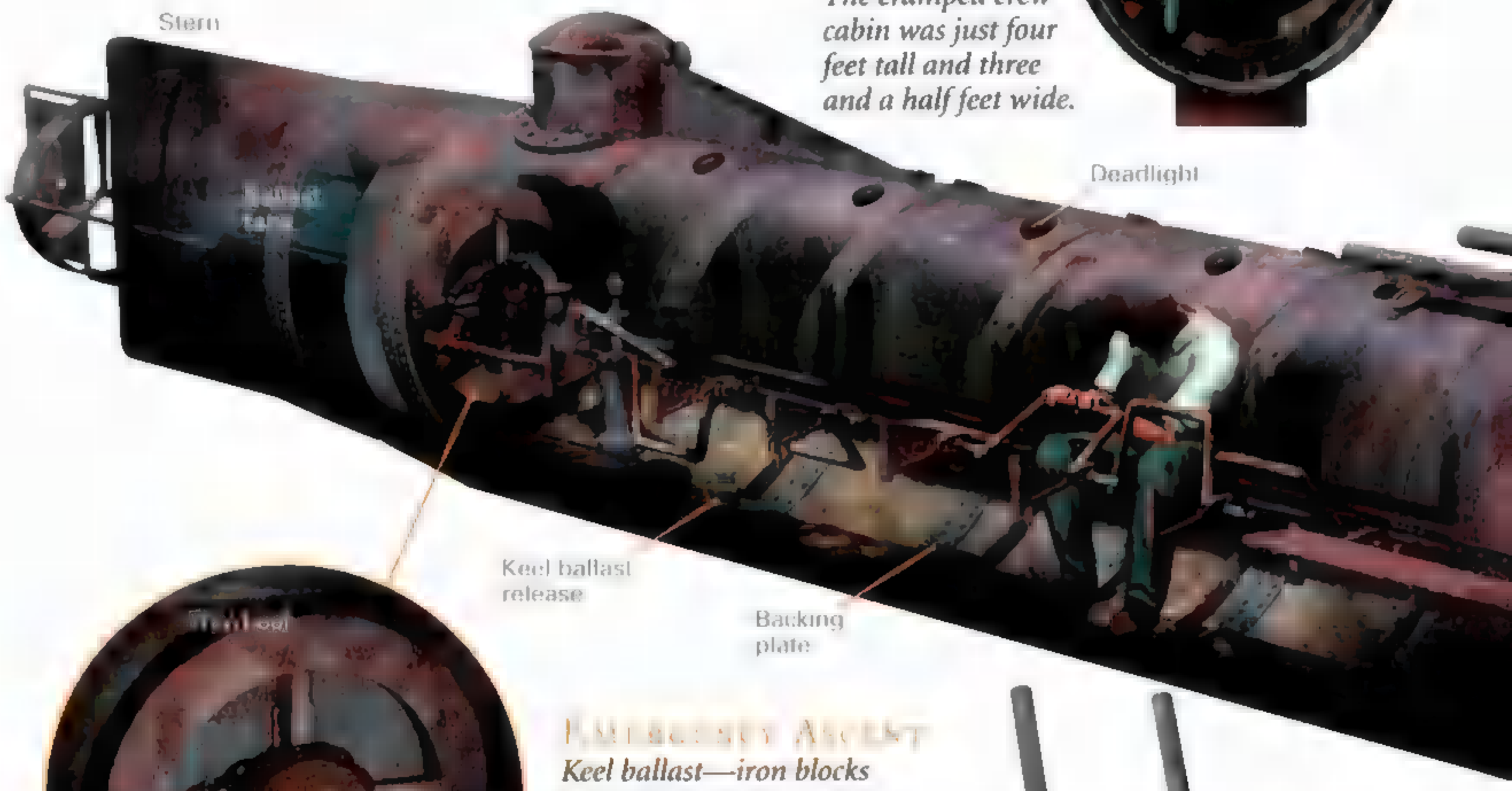
Despite all the *(Continued on page 96)*

H. L. Hunley

Confederate "Infernal Machine"

The cramped crew cabin was just four feet tall and three and a half feet wide.

Deadlight



Propulsion

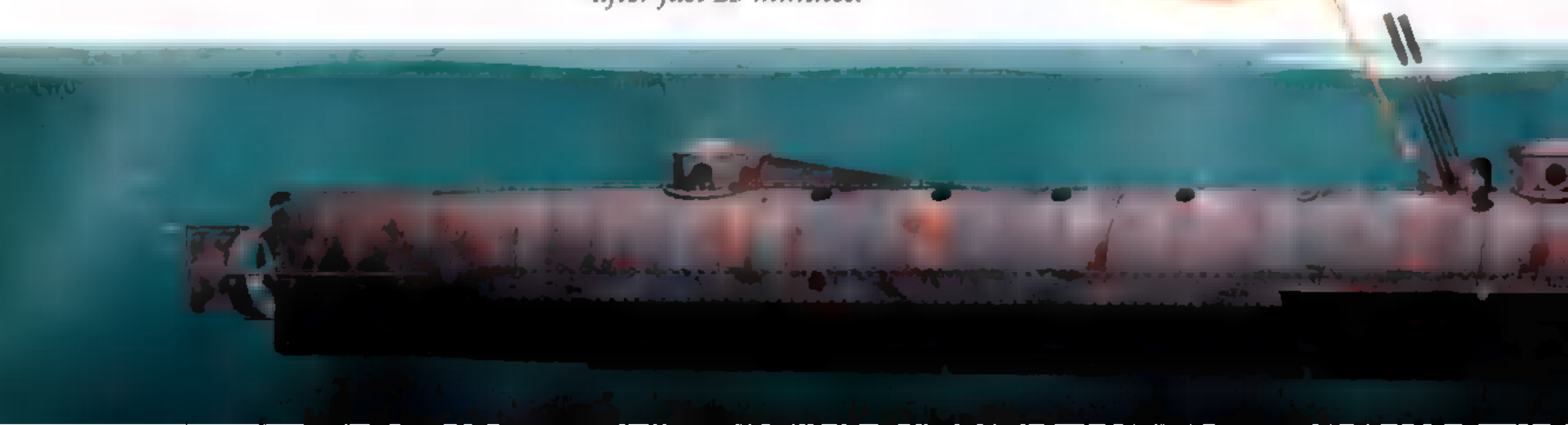
The Hunley*'s power plant consisted of a crankshaft turned by seven men and linked to the propeller by a chain. A large flywheel increased efficiency: As the crew cranked, the flywheel's momentum helped sustain speed.*

Ballast Keel

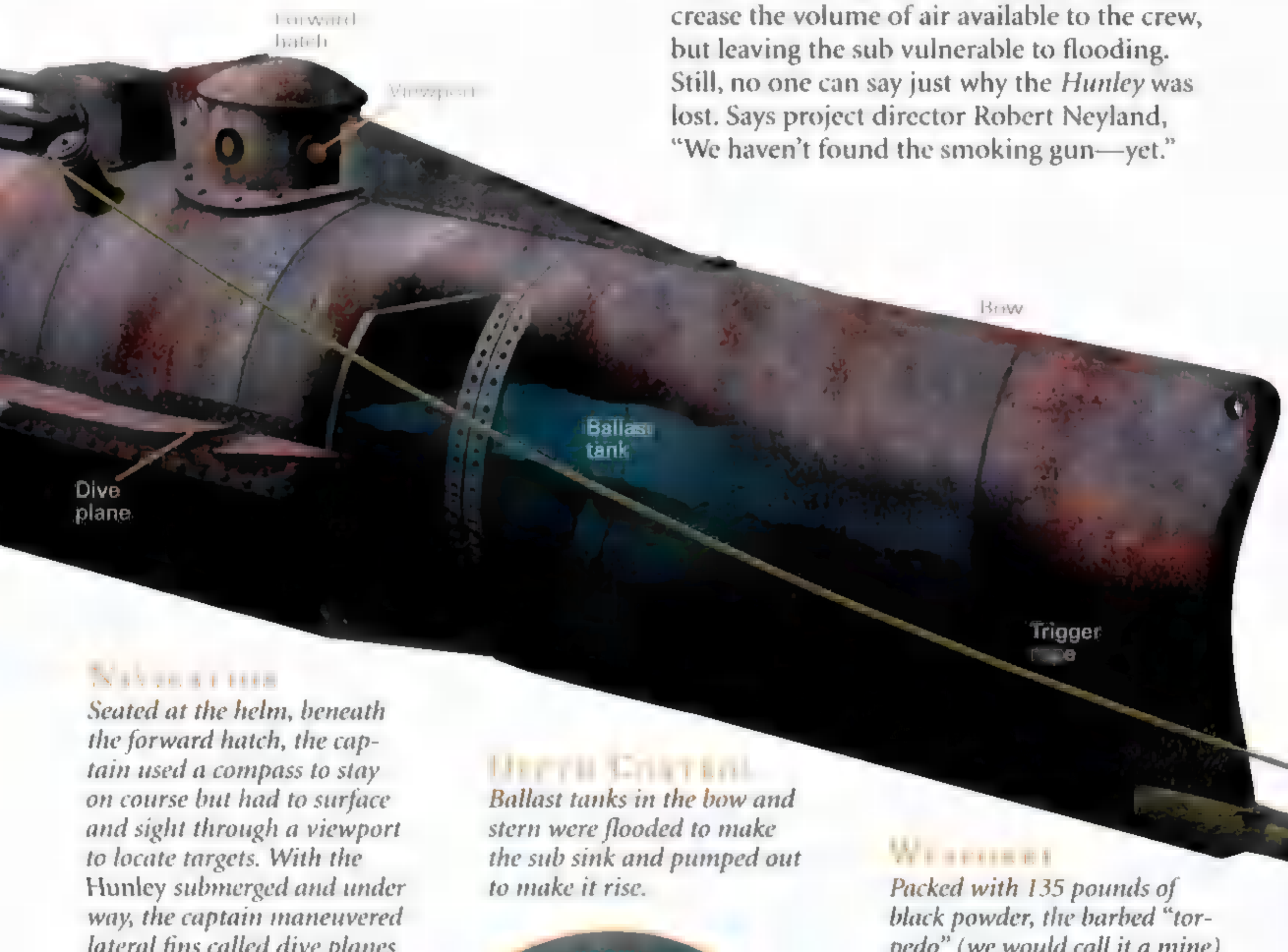
Keel ballast—iron blocks bolted to the bottom of the sub—could be jettisoned if the vessel became disabled on the bottom. Release mechanisms on the cabin floor will be x-rayed to see if the crew attempted to drop the weights.

Air Supply

Snorkel pipes and a bellows drew air into the sub but could be used only near the surface. To see how long they could go without fresh air, crewmen in training once sat on the bottom for two and a half hours, though their candle wouldn't burn after just 25 minutes.



"SHE WAS a beautifully modeled boat, and worked to perfection," wrote James McClintock, the *Hunley*'s chief designer. To maximize the speed and range of the 40-foot-long, man-powered sub, her builders made her as sleek as a barracuda. Hull plates were butted together and riveted to backing plates rather than lapped like fish scales. Rivets were flush with the hull, further reducing drag. "We've been awestruck by the ingenuity that went into this submarine," says project historian Mark Ragan. Yet, as Ragan admits, "The *Hunley* proved fatal to just about every man who entered its hull." The novel invention killed more Confederates (21) in fatal sinkings than it did Yankees (5) in battle. James McClintock blamed the mishaps on inexperienced submariners, not the submarine. But others have pointed out potentially lethal design flaws. For instance, fore and aft ballast tanks were left open at the top, perhaps to increase the volume of air available to the crew, but leaving the sub vulnerable to flooding. Still, no one can say just why the *Hunley* was lost. Says project director Robert Neyland, "We haven't found the smoking gun—yet."



Time in an Iron Bottle

SUSPENDED in a conservation tank precisely as she had rested on the seafloor (left), the Hunley was a sediment-filled tomb when archaeologists celebrated their first peek inside (right). A team led by Maria Jacobsen (far right) removed the sediment inch by inch to lay bare the sub's corroded interior (below) and the bones of her eight-man crew. Says project director Robert Neyland, "It was like excavating inside a bottle."

disincentives, so many sailors stepped forward that Dixon could take the cream and leave the dregs. Why? According to William Alexander, "I don't believe a man considered the danger which awaited him. The honor of being the first to engage the enemy in this novel way overshadowed all else."

But if test-pilot status was what they bargained for, they got the shaft—literally. Soon they were sweating for hours at the propeller crank, straining to reach the Yankee fleet that had been tipped off to the sub's existence by Rebel deserters from the *Indian Chief*. In response, the ironclads operating inside the harbor deployed an elaborate shield of chains. With these close-in vessels no longer viable targets, Dixon and his crew shifted their aim to the more vulnerable wooden ships now anchored ten or twelve miles from shore.

"They'd crank for hours and get maybe six or eight miles offshore," Ragan said. "Then they'd have to turn around and crank all the way back before dawn. And they did this three and four nights a week for over a month."

Every mission was an endurance test, sunrise sometimes catching the exhausted Confederates still within range of Union guns. Small picketboats that patrolled the waters closer to shore added to their peril. On several occasions the crew surfaced for air so near one of these launches that they could hear the bored Union sailors talking and singing.

Leashed to shore by the limits of their man-powered craft, the submariners were like chained dogs straining to bite a tormentor just beyond their reach. Then one night their taunter unwittingly came close enough to bite when the U.S.S. *Housatonic* took up position just four miles from shore. The moment had come for the *Hunley* to make history.

NOW, 136 years later, the engineers and archaeologists aboard the *Karlissa B* were about to get their chance to do the same. An assessment of the submarine in 1996 showed that her iron hull was surprisingly sound, a fortunate result of having been buried within about 20 years of sinking. But scrutiny of the rivets holding it together wasn't so reassuring.

"The nightmare we had from the very beginning was the sub breaking apart as we tried to lift it," said Robert Neyland, who invited experts from around the world to put forward proposals for lifting the 24-ton artifact in one piece. Perry Smith and Steve Wright of Oceaneering International, Inc., came up with the winning scheme: Slings passed beneath the sub and attached to a supporting truss would cradle the entire vessel like a hammock. Bags on each sling would then be filled with expanding polyurethane foam—similar to the stuff you can buy at the hardware store for insulating around drafty doors and windows. The foam-filled bags would conform to the hull's shape, ensuring that every inch was supported during the lift.

"We half-expected them to be piled up under the hatches . . . but there they were, still at their stations."

As simple as the plan sounds, it took heroic effort—and 2.7 million dollars—to pull it off. Nineteen divers toiled for three months in water so turbid that they had to work more by touch than sight. Claire Peachey, an underwater archaeologist with the National Park Service and the Navy, recalls, "I dove every day, two times a day for two weeks, and did not see the submarine once."

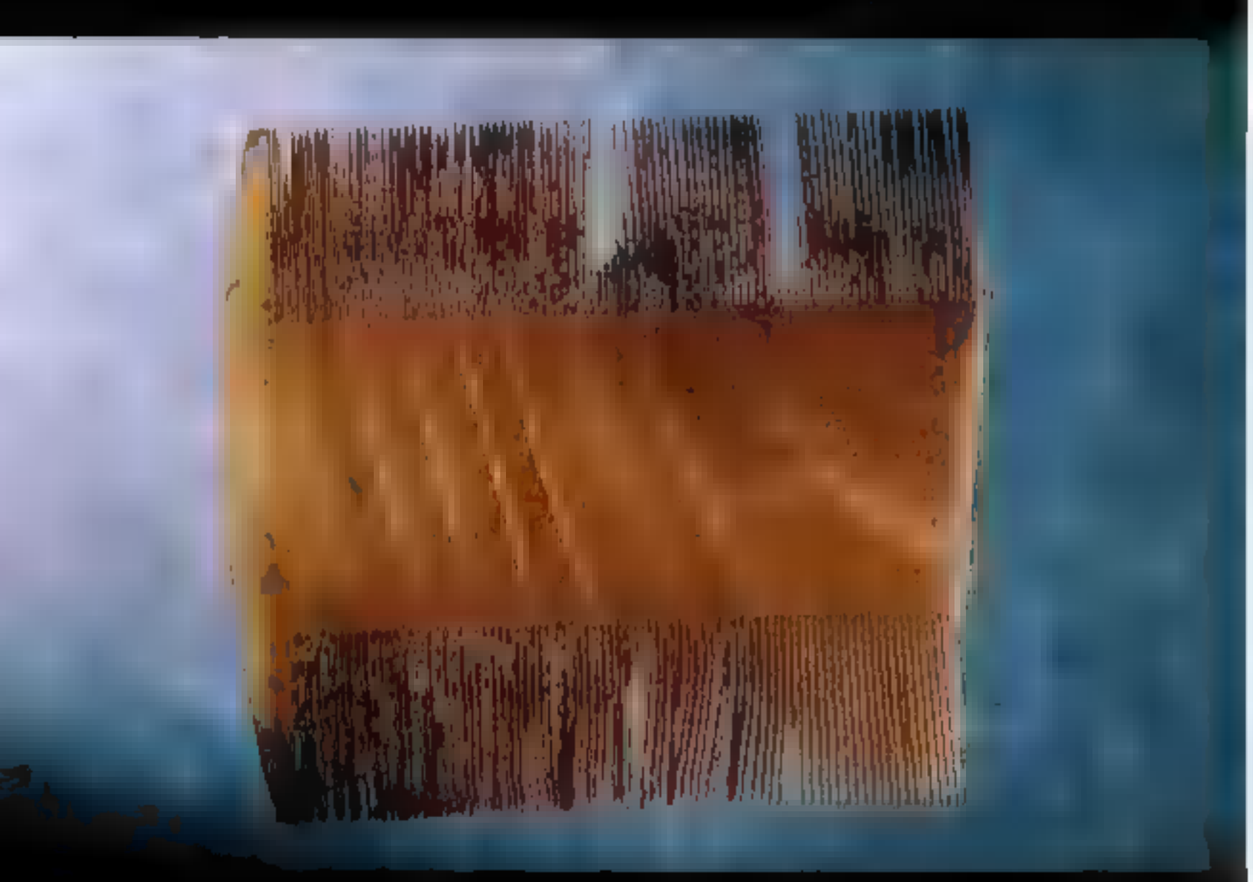
Using handheld suction dredges, divers carefully vacuumed away 25,000 cubic feet of sand and mud—the equivalent of 115 dump truck loads—to expose the submarine and any artifacts nearby. Two giant pilings were then sunk into the seafloor at either end of the sub to provide footings for the truss.

In planning for the lift, engineers worked up a mathematical model of the hull and the stresses it would be subjected to. "The moment of truth will come as the submarine breaks the surface," said David Conlin, a Navy and National Park Service archaeologist and the project's field director. "The instant it breaks that water-air interface, its weight will double, because it will no longer be supported by the water."

As the long-anticipated moment neared, divers made a final inspection and gave the

Artifacts of Intrigue

A YANKEE SPY aboard the Hunley? That theory surfaced after a Union soldier's ID tag (above) was uncovered inside the sub. A less tantalizing but likelier explanation is that the tag was kept by a Confederate crewman as a trophy of battle. Similarly, a U.S. Navy button (left) probably belonged to one of the submariners who left the federal fleet early in the war but kept his coat for the back of another. Mud as thick as fudge helped preserve all manner of artifacts: a thimble, a beard comb, even strands of hair.



all-clear signal. Without fanfare or countdown the crane operator throttled up the diesel engine and pulled a lever. Less than six minutes later the *Hunley*, snug in the padded sling, broke through the slight swell. She was intact, a time capsule unopened since the night she was lost. The mystery now: What was inside her?

IT IS OCTOBER 31—Halloween 2001—and I am standing in a room surrounded by skeletons. There is nothing ghoulish here, however, no rattling bones or bloodcurdling screams. Instead what I hear sounds like a curious cross between an anatomy exam and a bingo game.

"What do we know about this bone?" questions Douglas Owsley, a physical anthropologist with the Smithsonian Institution and one of the world's top forensic scientists.

"Lumbar vertebra, L-1, from grid seven, stored in box 52," replies archaeologist Harry Pecorelli, reading from a laptop computer.

"OK. Next question: Where did vertebra 1408 come from?"

"It was articulated to 1373."

"So we need to find 1373."

An assistant searches through a box of bones labeled "Unsorted," then disappears into a morgue cooler to track down the missing vertebra.

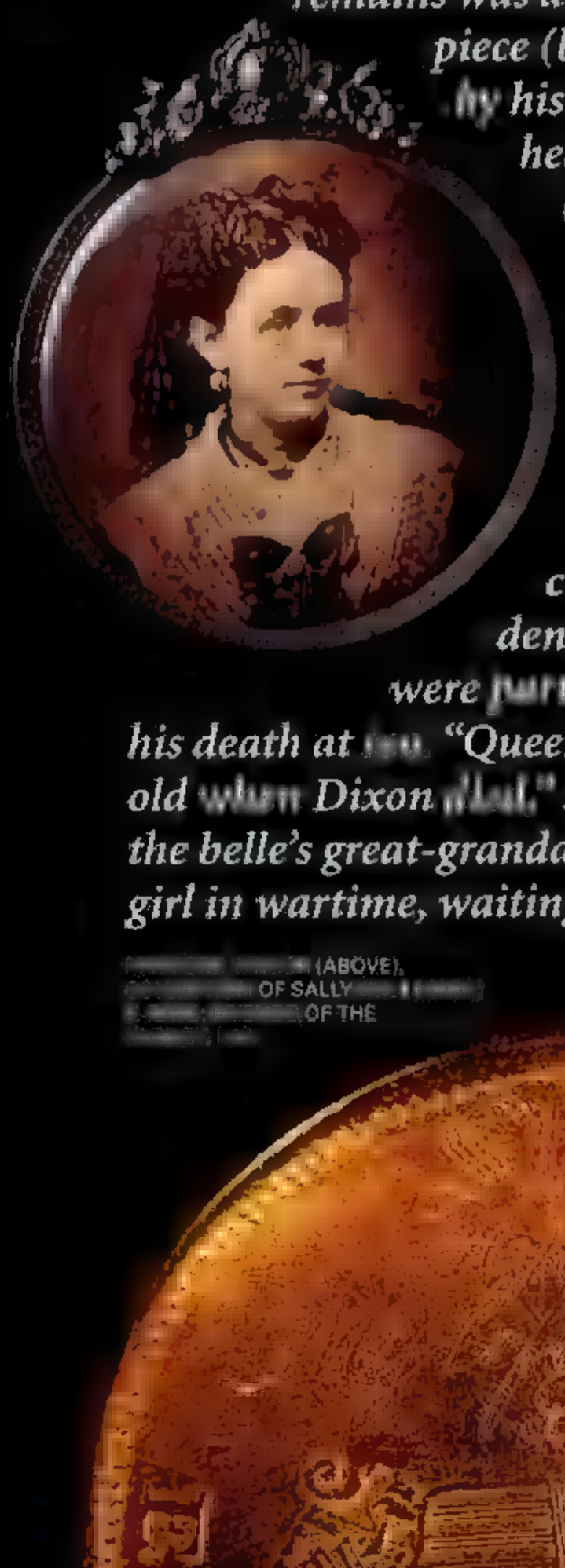
We are at the Warren Lasch Conservation Center, a state-of-the-art archaeology lab on the old Charleston Navy Base. The lab has been outfitted to accommodate the *Hunley* and the skeletonized remains of her crew, which Owsley is helping piece back together. All eight men were found inside the submarine, their bones remarkably well preserved in the mud that filled their iron coffin from stem to stern. Even their brains, though shrunken, remain, and will help reveal the cause of death. As archaeologists excavated the interior, carefully mapping the location of each bone and artifact, a freeze-frame of the *Hunley*'s final moments emerged. It was an eerie picture.

"Every man was still at his post, or very near it," said Warren Lasch, chairman of the nonprofit Friends of the Hunley. "We half-expected them to be piled up under the hatches trying to get out, but there they were, still at their stations."

The apparent absence of panic inside the

Articles of War . . . and Love

"I NEVER KNEW a better man: there never was a braver man in any service of any army," wrote a fellow officer of Lt. George Dixon, the Hunley's *commander. Archaeologists uncovered his skeleton at the sub's helm, a few feet from a heavily corroded lantern (inset, right)—which Dixon may have used to send a "mission accomplished" signal to shore. Excavators removed his torso in blocks of sediment that encased his bones and personal belongings, revealed in a ghostly x-ray image (right). Also gumming Dixon's remains was a memento, a $20 gold piece (below) given to him by his Alabama sweetheart, Queenie Bennett (left). Dixon kept the coin in his pocket, where it deflected a Yankee bullet at the Battle of Shiloh. The words he engraved on the coin after that incident, "My life Preserver," were particularly ironic, given his death at sea. "Queenie was just 16 years old when Dixon died," says Sally Newberry, the belle's great-granddaughter. "A young girl in wartime, waiting to learn his fate."*



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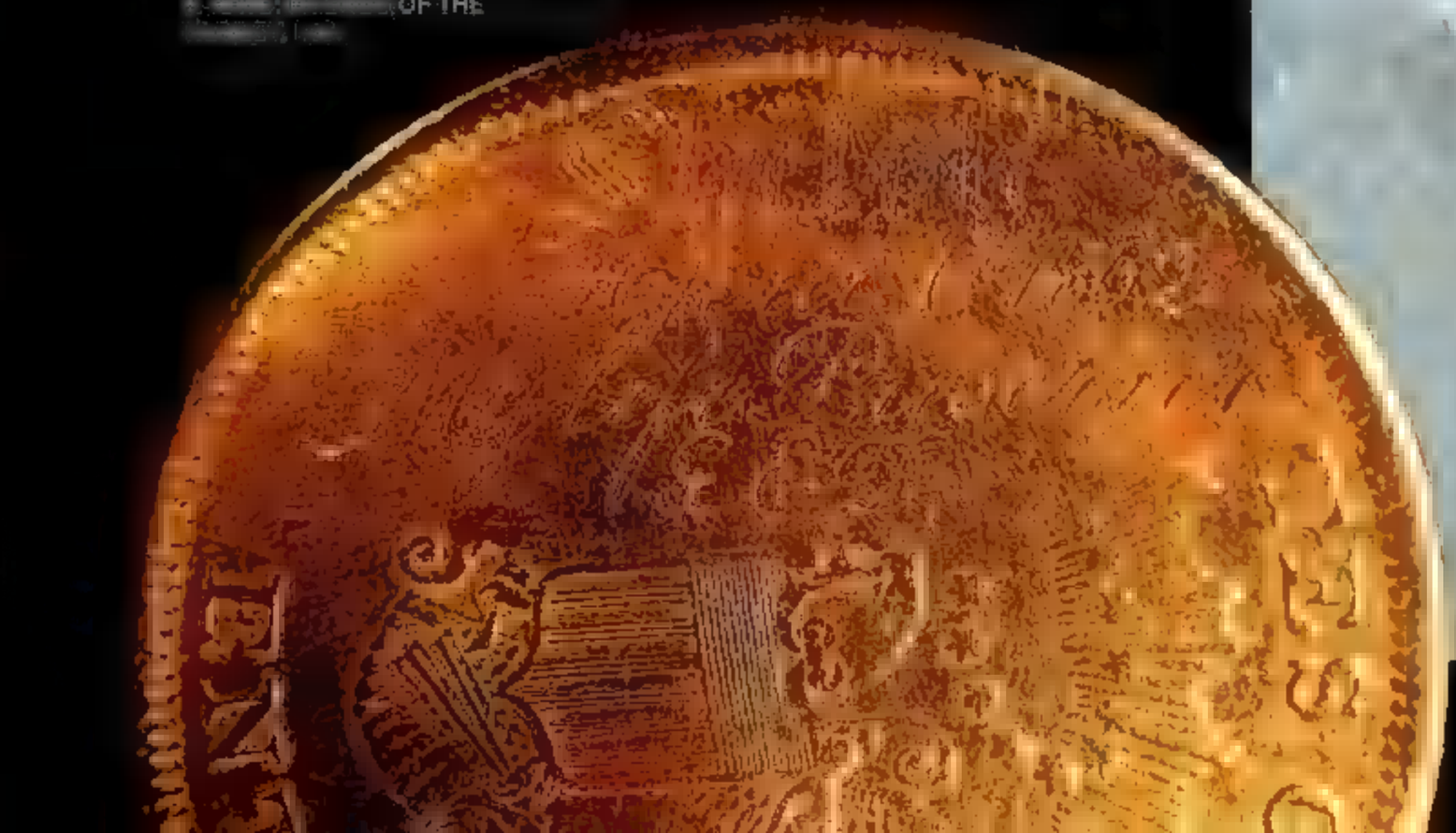
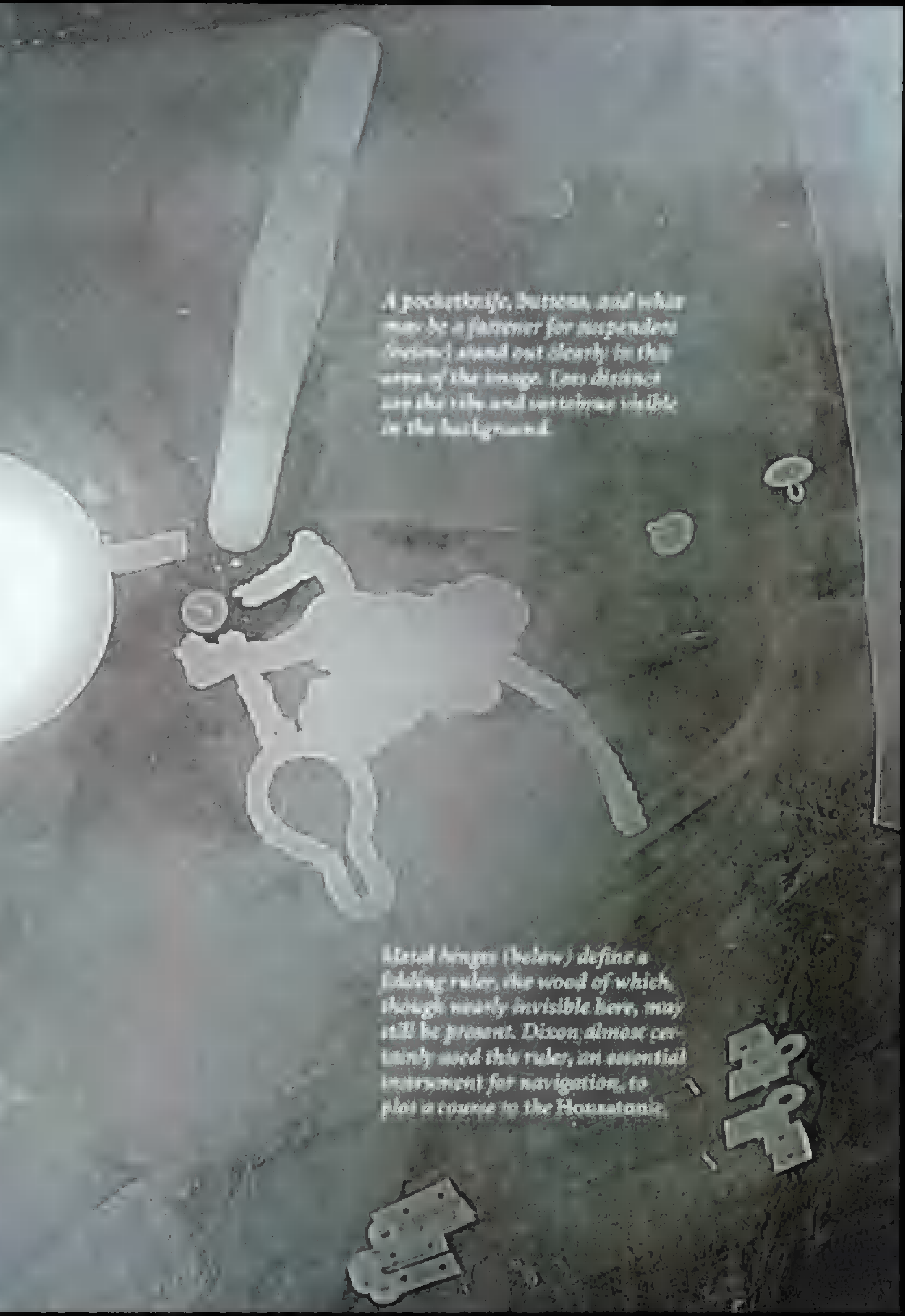




A pocketknife, buttons, and what may be a fastener for suspenders (below) stand out clearly in this area of the image. Less distinct are the ribs and vertebrae visible in the background.

Metal hinges (below) define a folding ruler, the wood of which, though nearly invisible here, may still be present. Dixon almost certainly used this ruler, an essential instrument for navigation, to plot a course to the Housatonic.

submarine led to speculation in the local press and among Hunleyphiles on the Internet that the crew died quietly from anoxia, or oxygen deprivation. Some theorists saw a modern analogy in the bizarre death of pro golfer Payne Stewart aboard a chartered jet in 1999. (The jet's two pilots and four passengers evidently died in their seats after a sudden loss of cabin pressure deprived them of oxygen.) Others cited William Alexander's writings on the *Hunley*, that Dixon and his men had an understanding that if ever they became hopelessly trapped inside the submarine, they would open the flood valves and end their suffering quickly rather than slowly asphyxiate.

Whether the crew starved for air like guttering candles or sat bravely as cold seawater rose above their heads is not yet possible to say. But months of digging inside the cramped confines of the sub's hull yielded a lode of solid clues—including a lantern that shed light on events following the attack. Confederates on Sullivans Island reported seeing a signal from sea—a blue light that meant the *Hunley* was headed home—some 40 minutes after the attack. Discovering a lantern aboard the submarine supports the report, which in turn rules out an old theory that the crew was killed by the concussion of the sub's torpedo.

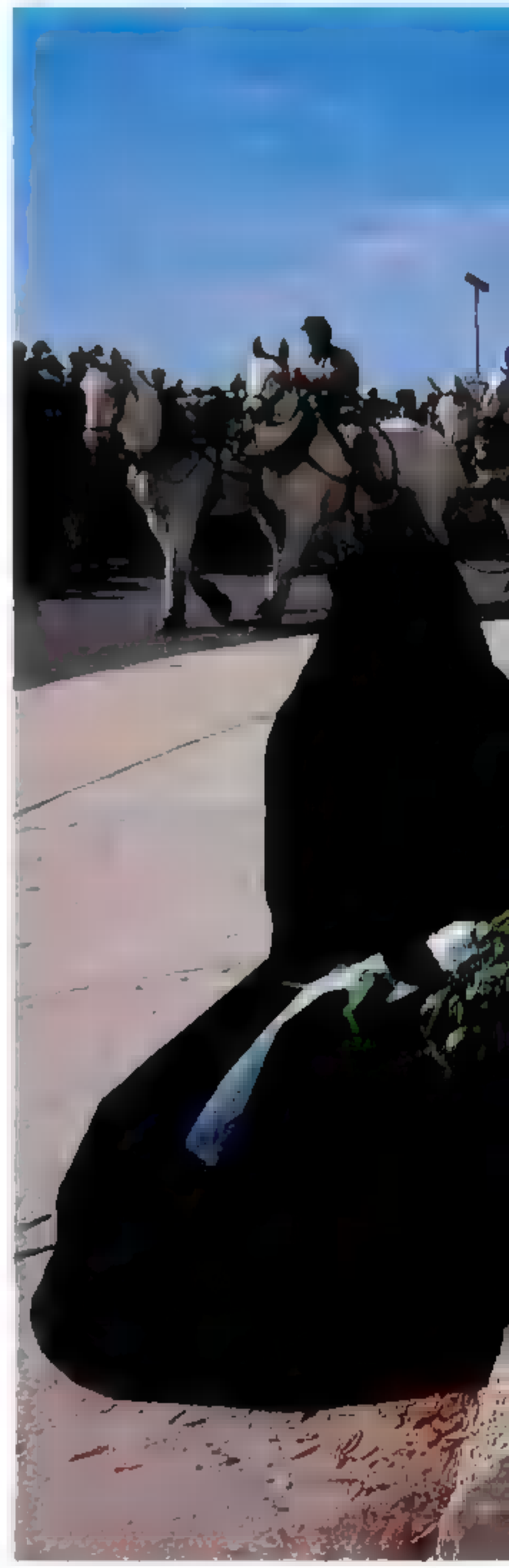
One of the project's most poignant moments came as Maria Jacobsen, the archaeologist in charge of the excavation, was probing Lieutenant Dixon's skeleton in preparation for lifting it out of the submarine. Jacobsen knew of the romantic old tale about a $20 gold piece reportedly given to Dixon by his Alabama belle, Queenie Bennett. During the Battle of Shiloh in 1862, so the story went, the big coin in Dixon's trouser pocket stopped a Yankee minié ball, saving his leg and probably his life. Wherever the war took him after that day, Dixon always carried the bullet-bent gold piece on his person.

That improbable story was in the back of Jacobsen's mind when her fingers touched a ridged surface. "I knew instantly that it was the edge of a coin," she recalls. The gleaming gold piece was warped, and a portion of one side had been buffed smooth and engraved. Jacobsen's hand was trembling as she read the inscription: "Shiloh. April 6th, 1862. My life Preserver. G.E.D."

So the tale was true. But finding the coin did more than authenticate a story; it also removed all doubt as to which skeleton was Dixon's. As for the seven others, their identities for now remain sketchy.

"The youngest looks to be about 19 or 20, the oldest maybe 45," said Owsley, basing his estimates on dental wear, signs of arthritis, and other effects of aging. Red stains on the upper arm bones of two sets of remains may have come from stripes on the sleeves

The haunting question remains, how and why did they die? For now, at least, the answer is as unknowable as their last words.



SCENE from an older South, women in black hoopskirts and men on white horses memorialize the first of three crews that died aboard the Hunley. *A similar ceremony for the final crew is planned for next year. "This is unfinished business for us," says Glenn McConnell, one of the organizers of the funeral. Sally Necessary echoes his sentiment: "I care what happens to these men. You feel a connection, however distant."*

of their uniforms, now rotted away. Records indicate that two members of the crew were recruited from an artillery unit, the uniforms of which were trimmed in red. By connecting such strands of evidence, Owsley hopes to positively identify each individual.

But the haunting question remains, how and why did they die? For now, at least, the answer is as unknowable as their last words.

"There was no black box inside this submarine," says Paul Mardikian, the *Hunley*'s senior conservator. A Frenchman who has cared for priceless artifacts from the *Titanic*, Mardikian will devote the next eight years or so to overseeing the painstaking conservation of the submarine. Once he finishes, plans call for the *Hunley* to become the centerpiece of a new maritime museum in Charleston.

In the meantime, a suite of forensic studies will yield more clues about the submariners and their mysterious end. When all the tests are completed sometime next year, Civil War reenactors will bear the remains of Dixon and his comrades through the streets of Charleston to a moss-hung cemetery named Magnolia. There they will be laid to rest alongside Horace Hunley and his crew.

Three days after the *Hunley* disappeared, General Beauregard issued his final order regarding the submarine: "As soon as its fate shall have been ascertained, pay a proper tribute to the gallantry and patriotism of its crew and officers." That long-standing order will at last be fulfilled. □

MORE ON OUR WEBSITE

Get updates on the findings of the *Hunley* forensic team, and find more images, field notes, and related websites at **nationalgeographic.com/ngm/0207**.

■ THE RISE OF LIFE ON EARTH

THE BIG

HOW FLOWERING PLANTS CHANGED THE WORLD

An explosion of flowering plants millions of years ago transformed the drab Earth into a bouquet of colors. A South African daisy and an extinct 49-million-year-old *Florissantia* count among the showoffs within a huge plant group that makes human life possible.

BLOOM

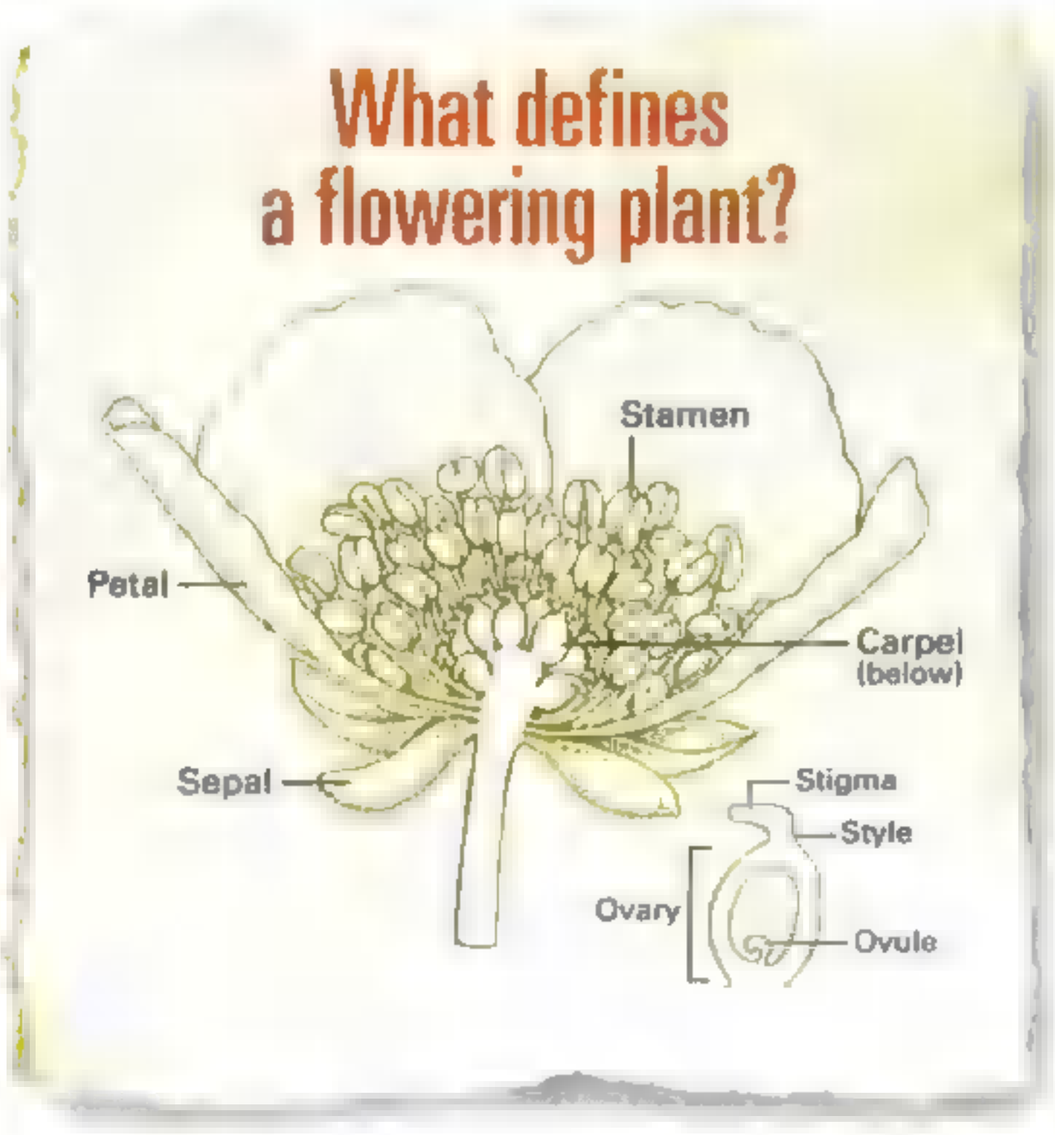
By MICHAEL KLESIUS
NATIONAL GEOGRAPHIC WRITER
Photographs by JONATHAN BLAIR

IN THE SUMMER OF 1973 sunflowers appeared in my father's vegetable garden. They seemed to sprout overnight in a few rows he had lent that year to new neighbors from California. Only six years old at the time, I was at first put off by these garish plants. Such strange and vibrant flowers seemed out of place among the respectable beans, peppers, spinach, and other vegetables we had always grown. Gradually, however, the brilliance of the sunflowers won me over. Their fiery halos relieved the green monotone that by late summer ruled the garden. I marveled at birds that clung upside down to the shaggy, gold disks, wings fluttering, looting the seeds. Sunflowers defined flowers for me that summer and changed my view of the world.

Flowers have a way of doing that. They began changing the way the world looked almost as soon as they appeared on Earth about 130 million years ago, during the Cretaceous period. That's relatively recent in geologic time: If all Earth's history were compressed into an hour, flowering plants would exist for only the last 90 seconds. But once they took firm root about 100 million years ago, they swiftly diversified in an explosion of varieties that established most of the flowering plant families of the modern world.

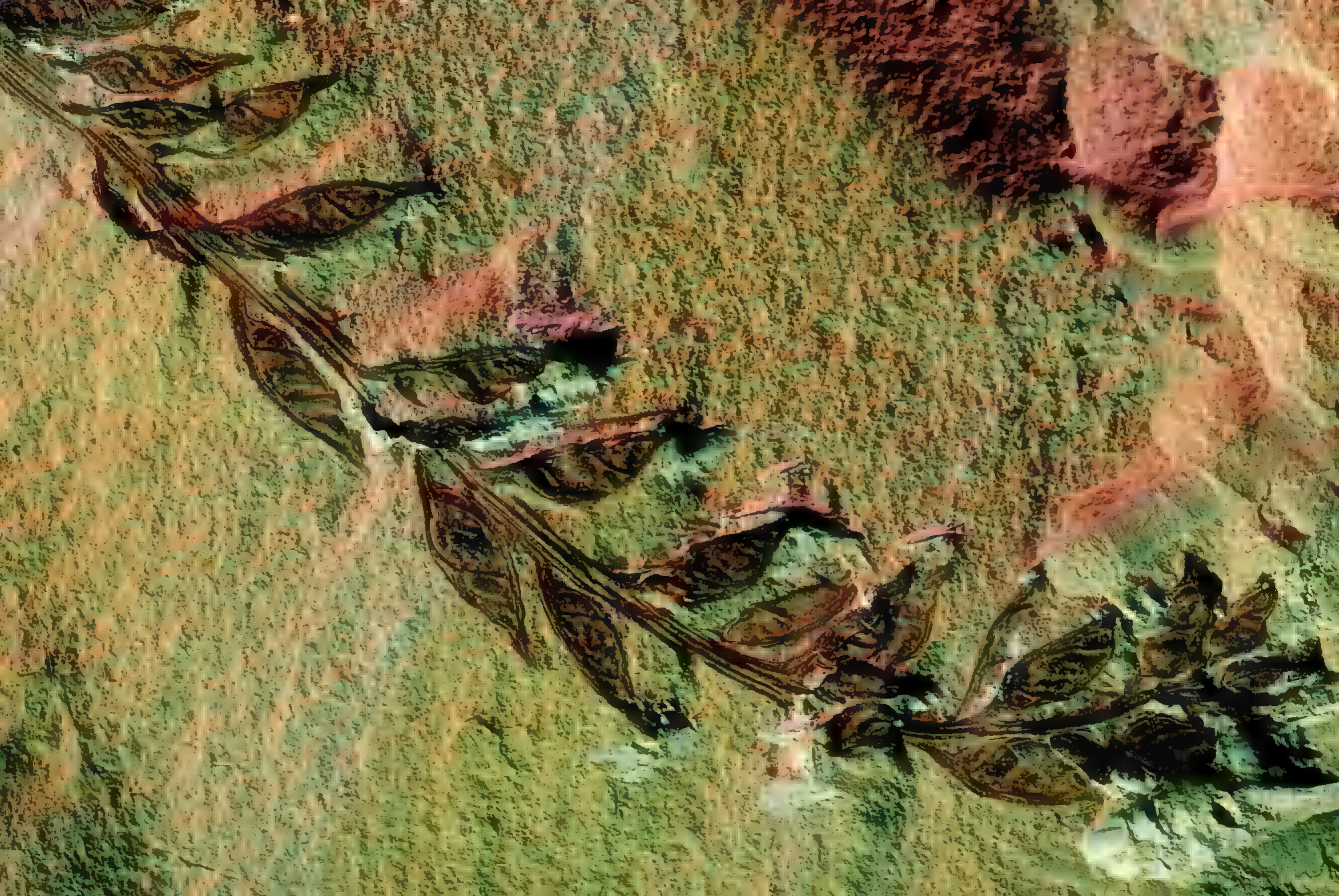
Today flowering plant species outnumber by twenty to one those of ferns and cone-bearing trees, or conifers, which had thrived for 200 million years before the first bloom appeared. As a food source flowering plants provide us and the rest of the animal world with the nourishment that is fundamental to our existence. In the words of Walter Judd, a botanist at the University of Florida, "If it weren't for flowering plants, we humans wouldn't be here."

From oaks and palms to wildflowers and water lilies, across the miles of cornfields and citrus orchards to my father's garden, flowering plants have come to rule the worlds of botany and agriculture. They also reign over an ethereal realm sought by artists, poets, and everyday



ART BY [redacted] BRUYNINCKX AND ALICIA BUELOW

First impressions: This fossil of a flowering plant, or angiosperm (right), ranks as one of the oldest found. Known as *Archaefructus liaoningensis,* it was discovered in China's remote Liaoning province in sediments dating back 130 million years. "It is so primitive that it hasn't developed the lovely flower typical of flowering plants," says paleobotanist David Dilcher. So why, if it lacks flowers, is it considered a flowering plant? Because it has the defining feature of all angiosperms: carpels enclosing seeds that grow into fruits (as seen in a cross section of a buttercup, at left). Says Dilcher, "Rather like mammals, which develop their young inside the mother, so flowering plants develop their seeds inside carpels."




RUBBER

Heady growth

Emma Fox of London's Kew Gardens removes a leaf of *Victoria amazonica,* largest of the water lilies, to make room for new leaves, which can unfurl from buds to six feet across in three days. Turned-up edges prevent overlap, maximizing exposure to light.

Fossils give us our only tangible hints of what early flowers looked like. They were tiny and unadorned.

people in search of inspiration, solace, or the simple pleasure of beholding a blossom.

"Before flowering plants appeared," says Dale Russell, a paleontologist with North Carolina State University and the State Museum of Natural Sciences, "the world was like a Japanese garden: peaceful, somber, green; inhabited by fish, turtles, and dragonflies. After flowering plants, the world became like an English garden, full of bright color and variety, visited by butterflies and honeybees. Flowers of all shapes and colors bloomed among the greenery."

THAT DRAMATIC CHANGE represents one of the great moments in the history of life on the planet. What allowed flowering plants to dominate the world's flora so quickly? What was their great innovation?

Botanists call flowering plants angiosperms, from the Greek words for "vessel" and "seed." Unlike conifers, which produce seeds in open cones, angiosperms enclose their seeds in fruit. Each fruit contains one or more carpels, hollow chambers that protect and nourish the seeds. Slice a tomato in half, for instance, and you'll find carpels. These structures are the defining trait of all angiosperms and one key to the success of this huge plant group, which numbers some 235,000 species.

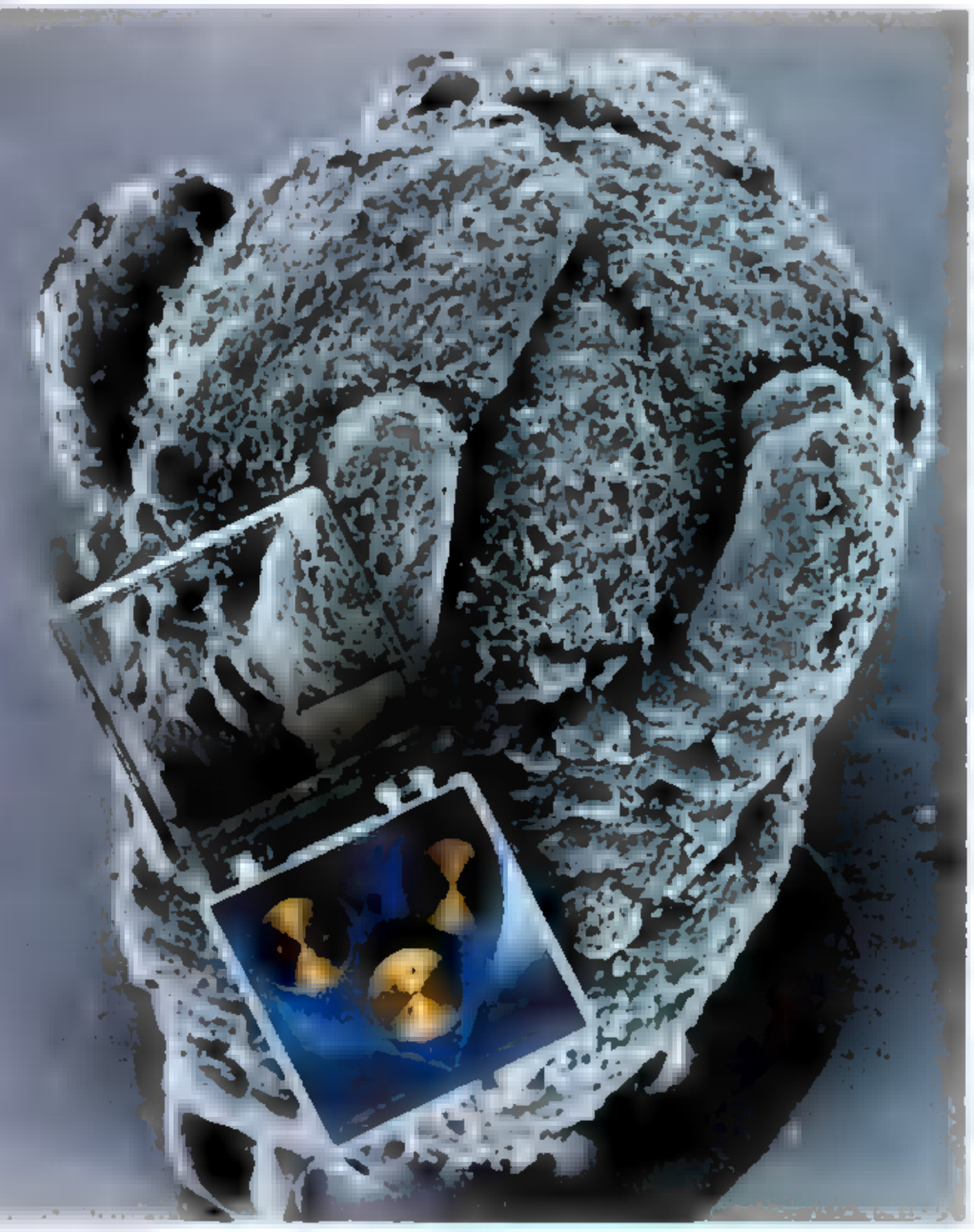
Just when and how did the first flowering plants emerge? Charles Darwin pondered that question, and paleobotanists are still searching for an answer. Throughout the 1990s discoveries of fossilized flowers in Asia, Australia, Europe, and North America offered important clues. At the same time the field of genetics brought a whole new set of tools to the search. As a result, modern paleobotany has undergone a boom not unlike the Cretaceous flower explosion itself.

Now old-style fossil hunters with shovels and microscopes compare notes with molecular biologists using genetic sequencing to trace modern plant families backward to their origins. These two groups of researchers don't always arrive at the same birthplace, but both camps agree on why the quest is important.

"If we have an accurate picture of the evolution of a flowering plant," says Walter Judd, "then we can know things about its structure and function that will help us answer certain questions: What sorts of species can it be crossed with? What sorts of pollinators are effective?" This, he says, takes us toward ever more sensible and productive methods of agriculture, as well as a clearer understanding of the larger process of evolution.

Elizabeth Zimmer, a molecular biologist with the Smithsonian Institution, has been rethinking that process in recent years. Zimmer has been working to decipher the genealogy of flowering plants by studying the DNA of today's species. Her work accelerated in the late

ROY LANDMER



Pressed in the pages of time

Stone, charcoal, and amber capture the look of ancient flowers, many of them extinct. During the Miocene epoch 10 to 20 million years ago, tree sap engulfed a Dominican legume flower (above), hardening into amber and freeze-framing the pollen as if windblown. Miocene flowers, relatively recent in geologic time, resemble the highly evolved flowers of today. Not so for those that emerged in the Cretaceous, more than 100 million years earlier. Such fossils recovered from clay pits in southern England by paleobotanist Chris Hill (facing page) indicate that the earliest flowers were tiny and lacked conspicuous petals. His finds support those of paleobotanist Else Marie Friis, whose minuscule specimens are mounted on disks and kept in plastic cases (left). Each disk holds two or more fossil flowers that have been sprayed with gold to sharpen images made by a scanning electron microscope (background). Turned to charcoal in primeval forest fires, the fossils reveal the simple elegance of primitive angiosperms.

Mapping a New Route to Old Roots

For centuries botanists have grouped flowering plants largely according to their physical form, or morphology. Paleobotanists, likewise, have relied on the morphology of fossils to determine lines of descent. In recent years, however, molecular biologists have adopted a new approach—comparing the DNA of living plants. Their conclusions, illustrated here, point to three foundational, or basal, lineages: Amborellaceae, Nymphaeaceae (water lilies), and Illiciaceae (star anises). The oldest line, Amborellaceae, currently includes just one species, a shrub that may be the closest living relative to the first flowering plant. Yet many plant species await discovery, and botanists admit that the time, place, and identity of the very first angiosperm remain what Charles Darwin dubbed "an abominable mystery."

BOTANICAL ART BY DIANE BRUYNINCKX;
MONTAGE BY ALICIA BUELOW;
INSECT ART BY SHAWN GOULD

NYMPHAEA 'DIRECTOR GEORGE T. MOORE'

A perennial aquatic flower long suspected of primitive ancestry, the water lily was only recently confirmed by DNA analysis as a basal lineage.

Pollinator Prison Smelling like decaying organic matter, flowers of the Dutchman's-pipe lure phorid flies inside, where they are trapped by guard hairs. Two days later the hairs wither and the flies go free, their bodies dusted with pollen for delivery to another Dutchman's-pipe.

Basal lineages Molecular biologists group modern flowering lineages based on similarities and contrasts in their DNA sequences. The groups that vary most from the rest do not, according to evolutionary theory, because they've undergone more genetic mutations, which means they must have split off before Amborellaceae, Nymphaeaceae, and Illiciaceae diverge near the family tree's base (hence basal) and together offer the best picture of the first angiosperms.

Magnoliids This group's namesake, the magnolia, boasts an ancient pedigree dating back more than 100 million years in the fossil record. The magnolia flower produces no nectar but rather a fragrance that attracts beetles for pollination and red seeds that birds disperse. Its 7,000 species grow in temperate and tropical regions of eastern Asia and eastern North and South America. The magnoliids include such familiar plants as sassafras, avocado, and black pepper.

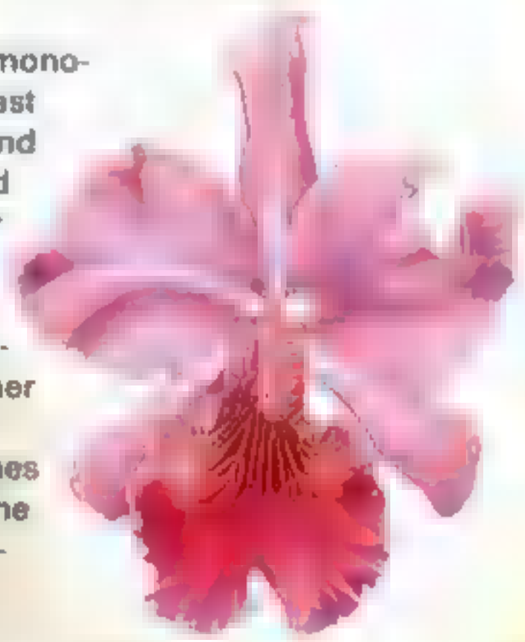
RICE

ORYZA SATIVA

The grass family of angiosperms is widely considered the most vital to humans. It includes not only rice but also all other cereals of early plant domestication, including corn, wheat, and oats.

[redacted]

CATTLEYA '[redacted]'



Poster child for monocots, orchids boast 24,000 species and 60,000 registered hybrids. With far more diversity and specialized pollination methods than any other flowering plant, orchids sometimes even resemble the insects that pollinate them.

CUTLEAF CONEFLOWER

[redacted] LACINIATA

This plant joins 19,000 species in a family marked by inflorescences, bunches of flowers clustered on a central stem.

[redacted] VANESSA CARDUI (PAINTED LADY [redacted])

BLACKBERRY

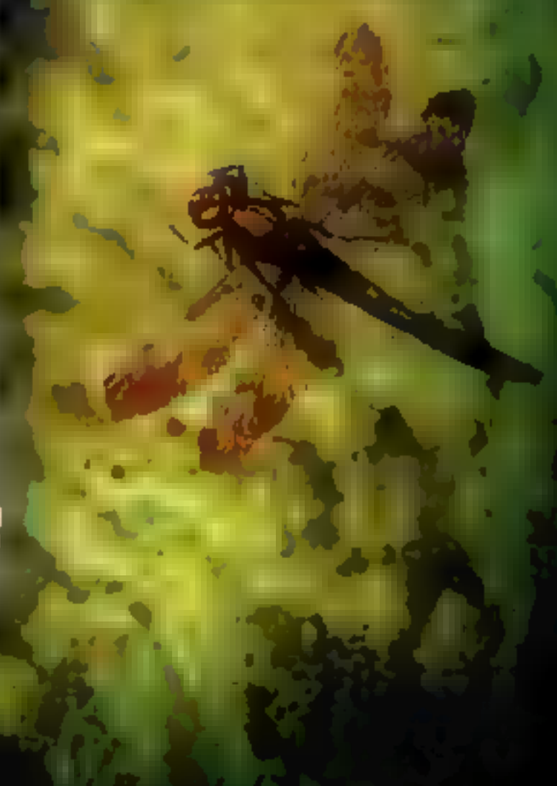
RUBUS LAC[redacted]

Within the rose family's 2,000 species, some, such as apples, peaches, and blackberries, provide fruit. Many grow thorns and have cupped symmetrical flowers.

ENGLISH OAK

[redacted] [redacted]

Pollinated by wind, the oak's flowers grow in long bunches, or catkins, sa[redacted] to resemble a cat's tail. A female flower, left, matures into an acorn, the tree's fruit.



Monocots Accounting for [redacted] species and a fourth of all angiosperms, monocots are characterized by a single cotyledon, or seed [redacted]. They [redacted] usually herbaceous—lacking [redacted] their pollen grains have [redacted] for germination. The group includes all grasses, such as corn, rice, and wheat; decorative flowers like lilies and orchids; [redacted] palm trees, which [redacted] effectively giant herbs because [redacted] are made of vascular bundles instead of true wood.

Eudicots With some 170,000 species, [redacted] comprises by far [redacted] largest number [redacted] A new [redacted] on [redacted] similarities, [redacted] cots include most of the plants formerly called dicots [redacted] their [redacted] cotyledons). Their leaves are often broad like those of magnoliids, and [redacted] species [redacted] wood [redacted] the ancient cone-bearing trees that predate [redacted] plants. In fact, DNA evidence suggests that the earliest angiosperms were probably [redacted].

What allowed flowering plants to dominate the world's flora? What was their great innovation?

1990s during a federally funded study called Deep Green, developed to foster coordination among scientists studying plant evolution.

Zimmer and her colleagues began looking in their shared data for groups of plants with common inherited traits, hoping eventually to identify a common ancestor to all flowering plants. Results to date indicate that the oldest living lineage, reaching back at least 130 million years, is Amborellaceae, a family that includes just one known species, *Amborella trichopoda*. Often described as a "living fossil," this small woody plant grows only on New Caledonia, a South Pacific island famous among botanists for its primeval flora.

But we don't have an *Amborella* from 130 million years ago, so we can only wonder if it looked the same as today's variety. We do have fossils of other extinct flowering plants, the oldest buried in 130-million-year-old sediments. These fossils give us our only tangible hints of what early flowers looked like, suggesting they were tiny and unadorned, lacking showy petals. These no-frill flowers challenge most notions of what makes a flower a flower.

TO SEE WHAT the first primitive angiosperm might have looked like, I flew to England and there met paleobotanist Chris Hill, formerly with London's Natural History Museum. Hill drove me through rolling countryside to Smokejacks Brickworks, a quarry south of London. Smokejacks is a hundred-foot-deep hole in the ground, as wide as several football fields, that has been offering up a lot more than raw material for bricks. Its rust-colored clays have preserved thousands of fossils from about 130 million years ago. We marched to the bottom of the quarry, got down on our hands and knees, and began digging.

Soon Hill lifted a chunk of mudstone. He presented it to me and pointed to an imprint of a tiny stem that terminated in a rudimentary flower. The fossil resembled a single sprout plucked from a head of broccoli. The world's first flower? More like a prototype of a flower, said Hill, who made his initial fossil find here in the early 1990s. He officially named it *Bevhalstia pebja*, words cobbled from the names of his closest colleagues.

Through my magnifying glass the *Bevhalstia* fossil appeared small and straggly, an unremarkable weed I might see growing in the water near the edge of a pond, which is where Hill believes it grew.

Fertile attraction

Enticed by nectar and other payoffs, animals become flowering plants' unwitting partners in pollen transport. A South African monkey beetle burrows deep into the center of a *Gazania* (top right) to feed on flower parts. The beetle then emerges with a luxuriant coat of pollen. Pollen-tipped anthers of the kangaroo paw plant (above) stroke an Australian singing honeyeater as it drinks. The vivid mottlecah eucalyptus (right) lures Australian honey possums, one of two mammal species that live only on nectar and pollen.

Flowering plants have conquered more than the land. They have sent roots deep into our minds and hearts.

"Here's why I think it could be a primitive flowering plant," said Hill. "*Bevhalstia* is unique and unassignable to any modern family of plants. So we start by comparing it to what we know." The stems of some modern aquatic plants share the same branching patterns as *Bevhalstia* and grow tiny flower buds at the ends of certain branches. *Bevhalstia* also bears a striking resemblance to a fossil reported in 1990 by American paleobotanists Leo Hickey and Dave Taylor. That specimen, a diminutive 120-million-year-old plant from Australia, grew leaves that are neither fernlike nor needle-like. Instead they are inlaid with veins like the leaves of modern flowering plants.

More important, Hickey and Taylor's specimen contains fossilized fruits that once enclosed seeds, something Hill hopes to find associated with *Bevhalstia*. Both plants lack defined flower petals. Both are more primitive than the magnolia, recently dethroned as the earliest flower, although still considered an ancient lineage. And both, along with a recent find from China known as *Archaefructus*, have buttressed the idea that the very first flowering plants were simple and inconspicuous.

LIKE ALL PIONEERS, early angiosperms got their start on the margins. In a world dominated by conifers and ferns, these botanical newcomers managed to get a toehold in areas of ecological disturbance, such as floodplains and volcanic regions, and adapted quickly to new environments. Fossil evidence leads some botanists to believe that the first flowering plants were herbaceous, meaning they grew no woody parts. (The latest genetic research, however, indicates that most ancient angiosperm lines included both herbaceous and woody plants.) Unlike trees, which require years to mature and bear seed, herbaceous angiosperms live, reproduce, and die in short life cycles. This enables them to seed new ground quickly and perhaps allowed them to evolve faster than their competitors, advantages that may have helped give rise to their diversity.

While this so-called herbaceous habit might have given them an edge over slow-growing woody plants, the angiosperms' trump card was the flower. In simple terms, a flower is the reproductive mechanism of an angiosperm. Most flowers have both male and female parts. Reproduction begins when a flower releases pollen, microscopic packets of genetic material, into the air. Eventually these grains come to rest on another flower's stigma, a tiny pollen receptor. In most cases the stigma sits atop a stalk-like structure called a style that protrudes from the center of a flower. Softened by moisture, the pollen grain releases proteins that chemically discern whether the new plant is genetically compatible. If so, the pollen grain germinates and grows a tube down through the style and ovary and into the ovule, where fertilization occurs and a seed begins to grow.

Casting pollen to the wind is a hit-or-miss method of reproduction. Although wind pollination suffices for many plant species, direct delivery by insects is far more efficient. Insects doubtless began visiting and pollinating angiosperms as soon as the new plants appeared on Earth some 130 million years ago. But it would be another 30 or 40 million years before flowering plants grabbed the attention of insect pollinators by flaunting flashy petals.

"Petals didn't evolve until between 90 and 100 million years ago," said Else Marie Friis, head of paleobotany at the Swedish Natural History Museum on the outskirts of Stockholm. "Even then, they were very, very small."

A thoughtful woman with short brown hair and intense eyes, Friis oversees what many

Come-hither colors and shapes

Dazzling petals do more than meets the eye. To humans a yellow day lily has a near-uniform hue. In the ultraviolet spectrum of light (invisible to humans but visible to bees) the lily appears two-toned, advertising a pattern attractive to bees. Because bees rarely visit red flowers, they may lack vision at the infrared end of the spectrum. Shape can also entice. Many orchids have an oversized petal, or lip, that offers ■ landing pad for flying insects.

A thirst for life

Spring blooms defy [illegible] near Nieuwoudtville, South Africa, showing the resilience of drought-adapted plants in places where other plants fail. A carpet of pink *Eberlanzia* surrounds a spiny kokerboom tree whose hollowed-out trunks once supplied Bushmen with quivers.

"People are attracted to living things. Smell, sight, beauty are all combined in a flower."

experts say is the most complete collection of angiosperm fossils gathered in one place. The fragile flowers escaped destruction, oddly enough, thanks to the intense heat of long-ago forest fires that baked them into charcoal.

Friis showed me an 80-million-year-old fossil flower no bigger than the period at the end of this sentence. Coated with pure gold for maximum resolution under an electron microscope, it seemed to me hardly a flower. "Many researchers had overlooked these tiny, simple flowers," she said, "because you cannot grasp their diversity without the microscope."

So we squinted through her powerful magnifier and took a figurative walk through a Cretaceous world of tiny and diverse angiosperms. Enlarged hundreds or thousands of times, Friis's fossilized flowers resemble wrinkled onion bulbs or radishes. Many have kept their tiny petals clamped shut, hiding the carpels within. Others reach wide open in full maturity. Dense bunches of pollen grains cling to each other in gnarled clumps.

Sometime between 70 and 100 million years ago the number of flowering plant species on Earth exploded, an event botanists refer to as the "great radiation." The spark that ignited that explosion, said Friis, was the petal.

"Petals created much more diversity. This is now a widely accepted notion," Friis said. In their new finery, once overlooked angiosperms became standouts in the landscape, luring insect pollinators as never before. Reproduction literally took off.

Interaction between insects and flowering plants shaped the development of both groups, a process called coevolution. In time flowers evolved arresting colors, alluring fragrances, and special petals that provide landing pads for their insect pollinators. Uppermost in the benefits package for insects is nectar, a nutritious fluid flowers provide as a type of trading commodity in exchange for pollen dispersal. The ancestors of bees, butterflies, and wasps grew dependent on nectar, and in so doing became agents of pollen transport, inadvertently carrying off grains hitched to tiny hairs on their bodies. These insects could pick up and deliver pollen with each visit to new flowers, raising the chances of fertilization.

Insects weren't the only obliging species to help transport flowering plants to every corner of the Earth. Dinosaurs, the greatest movers and shakers the world has ever known, bulldozed through ancient forests, unwittingly clearing new ground for angiosperms. They also sowed seeds across the land by way of their digestive tracts.

By the time the first flowering plant appeared, plant-eating dinosaurs had been around for a million centuries, all the while living on a diet of ferns, conifers, and other primordial vegetation. Dinosaurs survived for another 65 million years, and some scientists think this was plenty of time for the big reptiles to adapt to a new diet that included angiosperms.

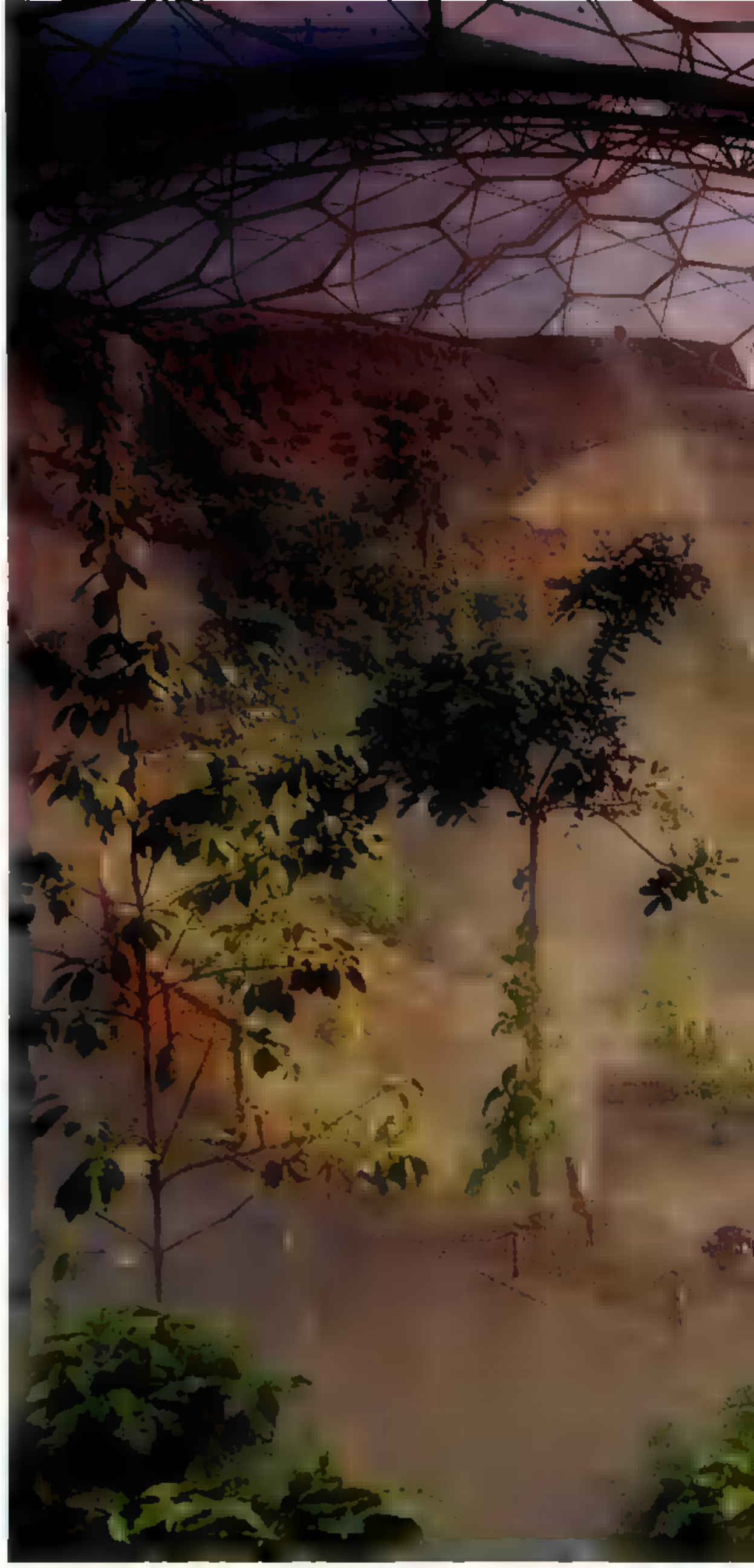
"Just before the dinosaurs disappeared, I think a lot of them were chowing down on flowering plants," says Kirk Johnson of the Denver Museum of Nature & Science. Johnson has unearthed many fossils between 60 and 70 million years old from sites across the Rocky Mountain region. From them he deduces that hadrosaurs, or duck-billed dinosaurs, subsisted on large angiosperm leaves that had evolved in a warm climatic shift just before the Cretaceous period ended. Referring to sediments that just predate the dinosaur extinction, he said, "I've only found a few hundred samples of nonflowering plants there, but I've recovered 35,000 specimens of angiosperms. There's no doubt the dinosaurs were eating these things."

Picture-perfect blooms

Flowers are a family affair for the Goldsmith clan, who founded a California seed company 40 years ago. Catering to a worldwide passion for flowers, the company employs 3,500 growers and suppliers in the United States, Guatemala, Kenya, and the Netherlands. Pursuing his passion for orchids, Robert Fuchs (top) inspects scores of hybrids at his Florida nursery. "They're easy to grow," he says. "Most people kill 'em with too much love."

Eden under glass

Morning showers mist 4,500 different plant species at Great Britain's Eden Project, the world's largest greenhouse. "Take all the humans off the Earth, and the plants would be quite happy," says Eden's Paul Travers. "Take all the plants off, and we couldn't survive."



Early angiosperms were low-growing, a fact that suited some dinosaurs better than others. "Brachiosaurs had long necks like giraffes, so they were poorly equipped for eating the new vegetation," says Richard Cifelli, a paleontologist with the University of Oklahoma. "On the other hand ceratopsians and duck-billed dinosaurs were real mowing machines." Behind those mowers angiosperms adapted to freshly cut ground and kept spreading.

Dinosaurs disappeared suddenly about 65 million years ago, and another group of animals took their place—the mammals, which greatly profited from the diversity of angiosperm fruits, including grains, nuts, and many vegetables. Flowering plants, in turn, reaped the benefits of seed dispersal by mammals.

"It was two kingdoms making a handshake," says David Dilcher, a paleobotanist with the Florida Museum of Natural History. "I'll feed you, and you take my genetic material some distance away."

Eventually humans evolved, and the two kingdoms made another handshake. Through agriculture angiosperms met our need for sustenance. We in turn have taken certain species like corn and rice and given them unprecedented success, cultivating them in vast fields, pollinating them deliberately, consuming them with gusto. Virtually every nonmeat food we eat starts as a flowering plant, while the meats, milk, and eggs we consume come from livestock fattened on grains—flowering plants. Even the cotton we wear is an angiosperm.

Aesthetically, too, angiosperms sustain and enrich our lives. We've come to value them for their beauty alone, their scents, their companionship in a vase, a pot, on Valentine's Day. Some flowers speak an ancient language where words fall short. For these more dazzling players—the orchids, the roses, the lilies—the world grows smaller, crisscrossed every day by jet-setting flowers in the cargo holds of commercial transport planes.

"We try to deliver flowers anywhere in the world within 24 hours of when they're cut," said Jan Lanning, a senior consultant with the Dutch Floricultural Wholesale Board, the world's turnstile for ornamental flowers. "The business has really globalized."

On my way home from Friis's lab in Sweden, I had stopped in the Netherlands, the world's largest exporter of cut flowers. I asked Lanning to try to explain the meaning of his chosen work. He leaned forward with a ready answer.

"People have been fascinated by flowers as long as we've existed. It's an emotional product. People are attracted to living things. Smell, sight, beauty are all combined in a flower." He

smiled at an arrangement of fragrant lilies on his desk. "Every Monday a florist delivers fresh flowers to this office. It is a necessary luxury."

Later that day in Amsterdam's Van Gogh Museum I spied a group of admirers crowded before a painting. I made my way there and pressed in among them. Suddenly I was staring at "Sunflowers," one of van Gogh's most famous works. In the painting the flowers lean out of a vase, furry and disheveled. They transported me to my barefoot youth at the edge of my dad's garden on a humid summer evening alive with fireflies and the murmur of cicadas.

The crowd moved on, and I was alone with "Sunflowers." My quest had come to this unexpected conclusion, an image of the first flower I can remember. Did van Gogh elevate the flower to an art form, or did the flower harness van Gogh's genius to immortalize itself in oils and brushstrokes? Flowering plants have conquered more than just the land. They have sent roots deep into our minds and hearts. We know we are passing through their world as through a museum, for they were here long before we arrived and may well remain long after we are gone. □

MORE ON [illegible] WEBSITE

Pick a flower from page 113 of this article and download it to your computer's desktop when you visit **nationalgeographic.com/ngm/0207**.

ZipUSA

A Capital Waterfront 2024

BY ANGUS PHILLIPS

PHOTOGRAPHS BY LANDON NORDEMAN

feeding frenzy.

Wallace Pruitt grew up on Tangier Island, Virginia, an isolated outpost in Chesapeake Bay where almost everyone crabs, oysters, or fishes. As a boy, he took a 17-hour boat ride to Washington, D.C., to work on the Maine Avenue Fish Wharf at Pruitt's Seafood, a business begun by his father, Elisha, in 1933.

Much has changed in Washington since Elisha's day. But the Potomac tide still lifts and lowers the fish barges twice a day, and Washingtonians still crowd the waterfront to barter with fishmongers from another world. And Pruitts are still there, hawking seafood.

On a bright summer morning Wallace's son Stewart stares up from one of his 60-foot-long barges where fish and shellfish in a hundred or so varieties lie arrayed on shaved ice. The tide is out and customers tower over him. A plump woman in stretch pants and golden necklaces glowers down. "How much for the crab legs?" she asks, pointing to a five-pound pack.

"Thirty-foiv," says Pruitt, in the soft accent of his home, where "time" is "toim" and "tide" is "toid."

"It was 25 last week," says the woman.

"No, ma'am, never 25."

"I'll give you $30," she says.

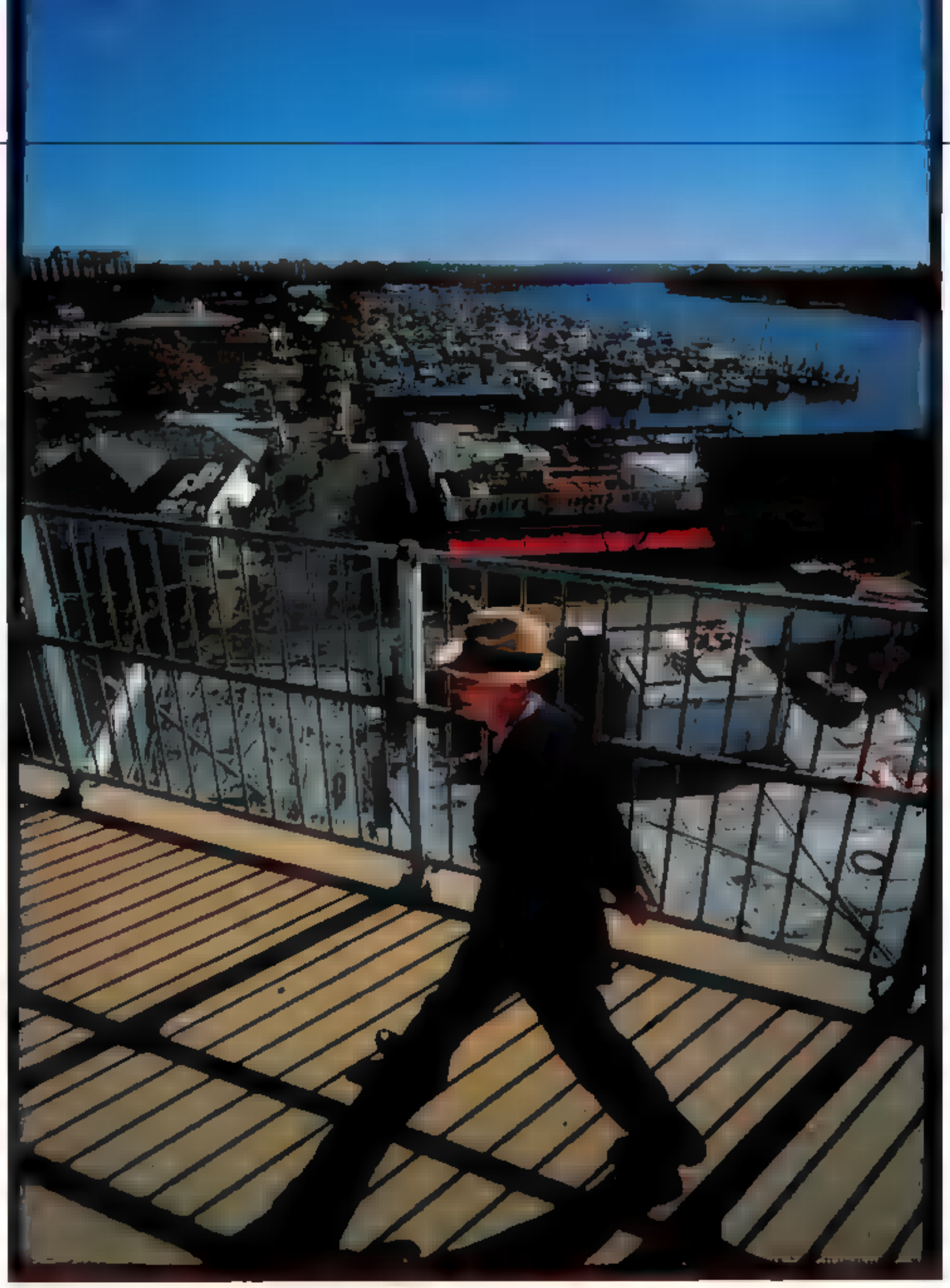
"Thirty-two," he says.

"Thirty-one," says she.

Pruitt cocks his head and, with a twinkle in his eye, asks, "Ain't you the girl I hugged last week?" So the deal is sealed in compromise and roguish goodwill, as it's been for a century and more at the foot of 11th and 12th Streets Southwest.

The floating fish market is a corner of Washington tourists don't see, even though it's less than a ten-minute walk from the Tidal Basin and the Bureau of Engraving and Printing, a few minutes more from the Jefferson Memorial and Washington Monument. No signs point to the block-long market. Locals battle gridlocked roads and swarms of buyers on weekends to haul away live or steamed crabs, oysters, and fish of all kinds, all seasons.

The closest most out-of-towners get are the massive, modern waterfront restaurants, just south of the barges, which lure tourists by the busload. Between the market and the restaurants, the Gangplank Marina and the Capital Yacht Club provide slips for around 400 boats,



Francis Case Memorial Bridge offers a gull's-eye view of fish market and marina.

[redacted] CRABS SOLD AT JESSIE TAYLOR'S SEAFOOD ON JULY 4: 600

TYPES OF SEAFOOD AVAILABLE EACH DAY: 50 to 100

FULL-TIME [redacted] RESIDENTS: 139 "live-aboards" in 107 slips

SMALLEST BOAT WITH TWO RESIDENTS: The *Pequod*, a 31-foot sailboat

LARGEST BOAT: The 104-foot *Sequoia*, a former presidential yacht

LARGEST LIVE-ABOARD DOG: Isabella, Great Dane

"... no place in America looks like it. Even New York is not as colorful."

including a hundred-plus houseboats and cruisers lived on year-round, some of them homes to government workers who forsake apartments for life on the water.

The modern restaurants and marina arose on a half-mile stretch of the Washington Channel after urban renewal in the 1960s ("urban removal," some called it) destroyed frame buildings, ramshackle shacks, and rambling eateries. Tour-boat wharves, town house clusters, and a small shopping mall round out today's sanitized Southwest waterfront. Yet the funky fish wharf lives on in olfactory glory.

Rubber boots keep fish cutters dry at the Virgo Fish House. Nearby, businessman David Leathers steps into dress shoes belowdecks on his live-aboard trawler before driving to his Maryland office.

No one knows how long it's been there. Merchants celebrated a 200th anniversary in 1994, citing 1794 as the earliest record of fishermen selling their catch on that spot.

Initially, boats brought goods directly to the wharf, traveling 60 miles downriver to Colonial Beach and Nomini, Virginia, in "buy-boats" to pick up fish and bring it back to sell.

By the 1960s refrigerated trucks delivered seafood fresher and cheaper. The roaming buy-boats were permanently made fast to the pier and later replaced by today's spacious, brightly lit steel barges.

Even though goods come by truck, most fishmongers still come from Chesapeake country and follow seafaring tradition by working "seven-on, seven-off" schedules: seven 14-hour days on duty, then home for a week to Tangier Island or Chincoteague, Smith Island, or Crisfield. Between the long day shifts workers sleep rough in plywood cabins atop

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the barges after winding down. They ride home exhausted in company vans that bring relief crews.

If the bargemen are much the same over the decades, the customer base is ever changing, says Sunny White, who runs Captain White's Seafood with his brother, Billy Ray, and Billy Ray's wife, Penny.

The brothers come to work astride gleaming Harley-Davidson motorcycles to cater to seafood lovers of every culture. There is Saba Saba, a Greek who grew up in Syria and immigrated to the United States 35 years ago, buying a bushel of crabs to share with "two Greeks, two Germans, and two Swiss."

The wharf, he says, "is the most interesting place in Washington. There is no place in America that looks like it. Even New York is not as colorful."

There's Walter Gee of nearby Oxon Hill, Maryland, arriving from Sunday service at Springfield Baptist Church in a panama hat and crisp, tailored pinstripe suit to buy shrimp and fish for a family gathering.

There's Hussain Allawi, lugging a ten-pound split carp he'll roast before a fire in the celebratory style of his Iraqi homeland. And Mai Anh, a native of Vietnam, haggling with one of Pruitt's staff over a hunk of mackerel, working the price down from $11.90 to $10.

"I'm not going to argue with you," says the salesman, wrapping up the prize and handing it over with a mock-weary expression.

"That's what we do," says Stewart Pruitt, looking on approvingly. "The supermarkets would throw it away rather than cut the price. We want to sell it, even if it is a teeny bit cheaper."

The deal done, Pruitt's dark eyes dart to the next potential customer strolling down the quay.

"Live crabs!" he calls out, carrying on the timeless tradition of fishmongers around the globe in this small, lively corner of the world's most powerful city. ▯

"When people [redacted] how I live," says a boater with a view, "I [redacted] wheels turning in their heads."

MORE INFORMATION

ON OUR WEBSITE There's more [redacted] 20024 at **nationalgeographic.com/ngm/0207.** Tell us why [redacted] should cover **YOUR FAVORITE ZIP CODE** at **nationalgeographic.com/ngm/zipcode/0207** or mail your suggestion to PO Box 98199, Washington, DC 20090-8199. E-mail: **zip@nationalgeographic.com**

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- [x] When you're pouring your cereal
- [x] When you're reading the paper
- [x] When you're walking the dog
- [x] When you get in your car
- [x] When you're driving
- [x] When you get out of your car
- [x] When you're in the elevator
- [x] When you walk in your office
- [x] When you're checking your email
- [x] When the phone rings
- [x] When the phone doesn't ring
- [x] When you meet with your boss
- [x] When you meet with your clients
- [x] When you meet anyone at all
- [x] When you walk to the deli
- [x] When you order your sandwich
- [x] When you finish your pickle
- [x] When you leave the office
- [x] When you pick up your cleaning
- [x] When you stop to get gas
- [x] When you walk into the store
- [x] When you're squeezing the melons
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Final Edit

THE BIG BLOOM

Plant-it Earth

E.T. doesn't live here, nor do the Jetsons. Instead, far more earthly beings dwell under these domes in Cornwall, England, home to the Eden Project. A public botanical garden that advocates better stewardship of the Earth, the Eden Project houses 135,000 plants in biomes ranging from rain forests to deserts and includes the world's largest greenhouse. For photographer Jonathan Blair, the conservatory—transformed to an eerie green by light filters from a Geographic TV crew—carries the message that "humans control the future of flowering plants, and their future does not look as good as their past."

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Cut it or keep it? Find out what tipped the balance for this photo at **nationalgeographic.com/ngm/0207.**

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NUCLEAR WASTE

Fallout From an Assignment

Lab tests produce an unexpected result

Lying under a radiation detector, photographer **Peter Essick** (above) had few fears that his coverage of nuclear waste had put him in danger. But to his surprise, the test at New Mexico's Carlsbad Environmental Monitoring and Research Center found that his body held an unusually high amount of radioactive cesium. Lab officials attribute this to reindeer meat eaten by Peter months earlier while on another assignment in a part of Sweden that had been affected by fallout from the 1986 Chernobyl disaster. The cesium poses little if any chance of cancer and will gradually leave his body. "So from a medical perspective it's a small risk," Peter says, "but it left me thinking about the contamination of the planet."


GNMENT
ENVELOPE THE WORLD

ALASKA

Patience, Personified

On a chilly morning in Haines, Alaska, **Norbert Rosing** (right) awaits the arrival of bald eagles feeding on salmon in the Chilkat River. "I was very, very lucky," Norbert says. "Park ranger Bill Zack told me it's been years since they had six sunny days in a row."

Like most wildlife photographers, Norbert doesn't mind long waits in pursuit of images. He spends weeks scouting sites, creating a blind, and waiting in it up to 12 hours a day for just the right moment to photograph his quarry. "I don't get bored in a blind," he says. "You always have to be on alert; as soon as something moves in a nest, I need to be on the camera right away."

ROSING

The German photographer was eager to take on this assignment, in part because "bald eagles are a huge success story for North America. The birds were almost extinct in the lower 48 states in the 1960s, and see how many are flying around today."

WORLDWIDE

Hiking through a national park in the Philippines in search of the Palawan peacock pheasant, author **Priit Vesilind** realized he was prepared for every hazard but the most obvious. "I went out into the rain forest—and it was raining," Priit recalls. His detailed notes looked like mush. When he returned to camp and the sun emerged, he set the notes out to dry (below). Priit learned his lesson: The next day he borrowed a friend's waterproof notebook. Priit retired earlier this year after a 28-year career on the magazine's staff, though he continues to write articles as ■ freelance. A native of Estonia whose family fled communism when he was a child, he counts his April 1990 article on the fall of the Berlin Wall ■■ his most satisfying assignment. "I helped knock it down," he says. "I took ■ sledgehammer and knocked the daylights out of it."

TIM LAMAN

Five years after he first began tracking efforts to raise the sunken Confederate submarine *H. L. Hunley*, staff author and native South Carolinian **Glenn Oeland** clambered aboard a crane barge outside Charleston Harbor to see the sub emerge from its watery grave. Getting on the barge was tricky. "The crane on the *Karlissa* ■ drops ■ cargo net they call a Billy Pugh, a birdcage-shaped thing with a wooden floor," Glenn explains. "You cling to the outside of it like a fly on a spiderweb, and they lift you up 60 feet over the ocean and lower you onto the barge. Let me tell you, I was holding on for dear life!"

Photographer **Jonathan Blair** has focused recently on large-scale projects, from shipwrecks to pterosaurs. "I wanted to do a story about something smaller," he says, and that led him to flowering plants. He learned "how plants work, how they do what they do, how they propagate and grow." He found that humans now often do the will of flowering plants. "If you were ■ pea or corn or a tomato, you'd say, 'We got them, they're well-trained now,'" he says. "When you look at the money and effort that humans put into growing plants, we're the bee, we've become mother nature."

MORE ■■ OUR WEBSITE

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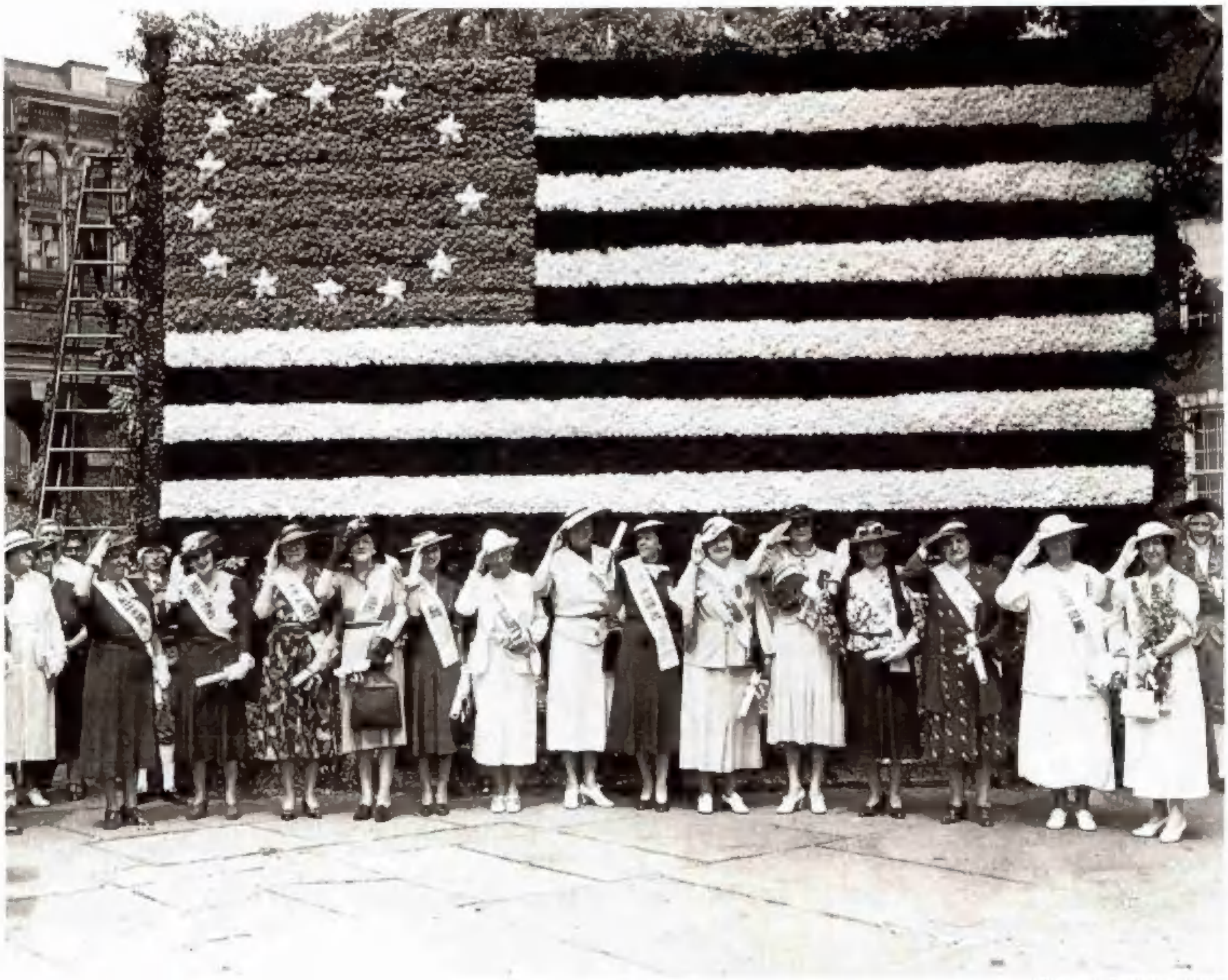

INTERNATIONAL NEWS PHOTOS

THE BIG BLOOM

A Flowering of Freedom

The salutes were unflagging outside Philadelphia's Independence Hall in 1938, as ceremonial representatives from each of the 13 original states celebrated the 150th anniversary of the ratification of the U.S. Constitution. Their backdrop banner, a 10-by-20-foot replica of one version of the 1777 flag, was composed entirely of red, white, and blue flowers. It was touted at the time as the "largest floral flag ever built in America."

This photograph was never before published in the magazine.

MORE ON OUR WEBSITE

You can send this month's Flashback as an electronic greeting card and access the Flashback photo archives at **nationalgeographic.com/ngm/flashback/0207.**

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THE STREAM AND BEYOND THE RIDGES
TO GRANDMOTHER'S HOUSE WE GO.